BILINGUAL MEMORY REPRESENTATION

IN KOREAN-ENGLISH AND SPANISH-ENGLISH BILINGUALS

A DISSERTATION

SUBMITTED TO THE SCHOOL OF EDUCATION

AND THE COMMITTEE ON GRADUATE STUDIES

OF STANFORD UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

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June 1995

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ABSTRACT

Dual coding theory (Paivio, 1971; 1986) explains human memory in terms of dynamic associative processes that operate on a rich network of modality-specific verbal and nonverbal (imagery) representations. These two systems are presumed to be interconnected, but capable of functioning independently. Interconnectedness means that representation in one system can activate those in the other, and independence implies that activation of the two systems should have an additive effect on recall. Dual coding theory was extended to explain memory representation in bilinguals (Paivio & Desrochers, 1980; Paivio & Begg, 1981). In the bilingual dual coding model, the two language systems are presumed to be interconnected at the referential level, but also function independently from each other and produce an additive effect on recall when both language systems are activated.

In this dissertation, bilingual memory representation was examined with special attention to two features of bilingualism that have not been the topic of much previous research. The first feature has to do with degree of proficiency in the two linguistic systems of the bilingual. Since most previous research has used balanced bilingual subjects, it was decided that a continuum of bilingual ability should be assessed in an adequate test of the bilingual dual coding model. The second feature involved bilingual memory processing in two groups of bilinguals whose languages differed in important ways. One group comprised Korean-English bilinguals and the other Spanish-English bilinguals. To date most studies of bilingual memory have involved language combinations that are linguistically similar. This study allowed for a comparison of the bilingual dual coding model with a language group (Korean-English) that has not been studied before. Thus, the purpose of this dissertation is to examine the following research questions: (1) Are there differences in bilingual memory representation depending on the degree of bilinguality? and (2) Does linguistic similarity and/or difference between the two languages of the bilingual influence recall and recognition memory?

This dissertation consists of three consecutive studies. Study I was an exploratory study of the bilingual dual coding model using unbalanced Korean-English bilingual

university students. 18 subjects who were native speakers of Korean and had learned English as a foreign language were shown a list of items in three different modes (pictures, Korean words, English words) and asked to code them by writing the name of the picture, translating the words, or copying the words. An incidental recall task was used. Findings indicated that Korean-dominant unbalanced bilinguals recalled as many translated items as picture-named items. This finding contradicted earlier research findings where balanced bilinguals recalled picture-naming items significantly more than translated items. The results of this exploratory study indicated that a more elaborated study which incorporated degree of linguistic proficiency in bilinguals was called for.

Study II was conducted to select stimulus items which were scaled for equivalence in three different languages (Korean, Spanish, and English). A total of sixty subjects from the three language groups were given a list of 180 items (in both words and pictures) which had been pre-selected based on high imagery and familiarity. Subjects were asked to rate each item for its picture clarity, word imagery, and item familiarity. Items were selected based on equivalent high ratings for picture clarity, word imagery, and item familiarity in all three languages. A list of sixty stimulus items was finalized and used in Study III.

Study III was designed to systematically examine bilingual memory representation in two different language groups. 340 subjects (164 Korean-English bilinguals and 176 Spanish-English bilinguals) participated in this study. Each subject's proficiency level was assessed by a self-rated proficiency questionnaire. Subjects in each bilingual group were subsequently placed into one of three proficiency levels. In the Korean group, there were 37 balanced bilinguals, 72 Korean-dominant, and 55 English-dominant unbalanced bilinguals. In the Spanish group, there were 81 balanced bilinguals, 24 Spanish-dominant, and 71 English-dominant unbalanced bilinguals. Subjects were shown 60 stimulus items: 20 pictures, 20 Korean (or Spanish) words, and 20 English words. Three coding conditions were employed by asking subjects to code each item by writing the name of the picture, translating it in the other language, or copying it as it was shown. Coding language was also introduced as a variable, by asking subjects to write half of the stimulus items in their stronger language and the remaining half in the weaker language. After the coding task, subjects were unexpectedly asked to recall as many items as possible. They were then given the 60 items and asked to identify the presenting mode of each item (picture, Korean/Spanish word, or English word).

Analyses showed that there was no language group difference in number of recalled items. The recall pattern by coding condition and coding language for all three proficiency

groups was strikingly similar for both Korean-English and Spanish-English bilingual groups. Significant differences between the three coding conditions were found with the highest recall for items in the picture-naming condition, next for the translation condition, and the lowest recall for items in the copying condition. The same pattern of recall was obtained for the three proficiency groups, especially when the stimulus items were coded in Korean (or Spanish). In the case of English coding, the mean number of recalled items between the picture-naming and translation conditions was not significantly different for the two unbalanced bilingual groups, which replicated the results of the Study I. However, both balanced groups recalled significantly more items in the translation condition than those in the copying condition.

Analyses were performed on the accuracy of identifying the presenting mode of items. The number of items whose stimulus mode was identified was examined. A pattern similar to that found for the recall memory task was also obtained in this task. That is, overall, the presenting mode of items in the picture-naming condition was correctly identified significantly more than for those in the translation and copying conditions. This pattern was true for both Korean and Spanish language groups regardless of coding language and proficiency group. However, there was a significant interaction between coding language and proficiency group. Subjects correctly identified presenting mode of stimulus items significantly more when they were coded in the weaker language, but this finding was confined only to the copying condition.

The findings from this study support the dual coding theory. Human cognitive activity is mediated by two symbolic systems, one for verbal processing and the other for imagery processing, and when both systems are activated there is an additive effect on recall. Findings from this study also support the bilingual dual coding model. Results revealed higher recall for items which required activation of both language systems. Neither linguistically similar languages (Spanish vs English) nor dissimilar languages (Korean vs English) resulted in different findings in bilingual memory recall. The degree of proficiency in the two languages, however, did result in differences in recall and recognition memory. A bilingual's proficiency level in each language is related to the degree of effort required to process information and recall it as demanded in this study.

ACKNOWLEDGMENTS

It has been a long journey from the beginning of my Ph.D. program at Stanford until now when I am nearing the end of one of the great chapters of my life. First of all, I appreciate God's grace which made my long-sought goal a reality. Everything was possible with His care and love. With His grace, I had the opportunity to begin the Ph.D. program at Stanford; with His care, I successfully completed my degree; and with His love, I was able to overcome all the difficulties that I confronted throughout the time I was a student.

I have to thank my wonderful advisor, Professor Amado M. Padilla, who, for six years, has patiently helped me to attain my Ph.D. degree. I appreciate his intellectual guidance, his gracious time, his endless patience, and his great care. At the beginning of my Ph.D. program, he gave me opportunities to read and discuss with him the literature on bilingualism and cognitive psychology, from which I eventually identified my dissertation topic. He has always been there when I needed help or just someone who would listen to me as I worked to untangle my thoughts on the intricacies of bilingualism. He is not only an intellectual guide but also a wonderful counselor. Whenever I was in a stressful situation, he patiently took care of me by listening to me and providing wise advice. I am indebted to him for completing the Ph.D. degree. I know that I could not have finished this dissertation without his support.

I thank Professor Kenji Hakuta who was my second advisor and a member of my dissertation committee. I appreciate his sparkling comments on bilingualism and his continuous encouragement of my bilingual memory research. I also thank Professor Peter Sells in the Linguistics Department who was willing to serve on my dissertation committee. I appreciate his helpful feedback. I have to thank Professor Robert C. Calfee who was a fourth reader of the dissertation. I appreciate his insightful feedback on the methodology and interpretation of my findings which he offered during my proposal hearing and also at my defense of the dissertation. I also thank Professor Guadalupe M. Valdes who helped me in recruiting of Spanish-English bilingual subjects for my research.

I was very fortunate to be surrounded by friends in the School of Education who continuously encouraged each other and exchanged ideas as well as support. I especially would like to express my appreciation to Dr. Juan Aninao who has been a fellow graduate student and a mentor to me over the course of my entire stay in the School of Education at Stanford. I was also very lucky to have many wonderful friends from the Korean graduate students community and from the Korean Dae Sung Presbyterian Church. Without their support, prayers, assistance, and loving care, I could not have survived the strenuous life of a single parent and doctoral student. I especially thank my wonderful neighbors, the Hoff family, for their warm support and prayers over the last three years. I send them all a heartfelt thank-you!

Finally and most importantly, I have to thank my great family. I appreciate my parents-in-law who supported me all the time I have been at Stanford and who continuously encouraged me to finish my Ph.D. degree. I appreciate their endless prayers and their financial sacrifices for me. I also appreciate the prayers offered by my three grandmothers, one of whom passed away a month ago. I appreciate their sincere support. I thank my loving mother and father whose care and prayers led me to completion of my doctorate degree. I appreciate their endless love and support for their only daughter. I also thank my only brother who has always taken care of me over the phone while he was also pursuing his Ph.D. degree. I have to thank my wonderful husband who has been the best supporter in my life. I appreciate his encouragement to begin my Ph.D. program, and his support and constructive criticism of my work while we were both studying for our Ph.D. together. I especially appreciate his endurance over the last three years since he returned to Korea alone after completing his degree. It must have been hard for him to live alone without his family, but he has not complained at all. He has only told me that I had to concentrate on my studies and finish my degree. I really appreciate his enduring love and support. Finally, I have to say tearfully "Thank-You" to my dear daughters, Heesoo and Heejin, who have experienced all the joys and agonies with me over the last six years, most especially the last three years without their father. They have been great and my comfort. They always took good care of their busy mother. I especially appreciate Heesoo's role as a little mom for her sister. I thank God for His care of my daughters and for allowing them to grow in Him immaculately.

Since all the glory that I have comes from Him by His grace, I return this glory back to Him and praise Him. Amen.

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CHAPTER 1

INTRODUCTION

Bilingualism is a worldwide phenomenon that has been discussed extensively from various perspectives. One of the important questions that has often been addressed in bilingual research, but which is still not clearly understood has to do with memory processes in bilinguals. There has been a long debate on how bilingual memory processes occur (for a review, see Grosjean, 1982, chapters 4 & 5; Hakuta, 1986, chapter 4; Hamers & Blanc, 1989, chapter 4; McCormack, 1977; Paivio, 1990, chapter 11; and Paivio & Desrochers, 1980). The most controversial point in bilingual memory research has been the way in which bilinguals organize and represent knowledge of two languages in their memory. The most frequently asked questions regarding bilingual language processing are as follows: Does the ability to speak and understand two languages mean that the person has two ways of processing linguistic information one for each language? Are the two language systems functionally connected to a common cognitive or conceptual system?

Throughout the long debate on bilingual memory, some research has shown that bilinguals have a separate memory for each language (e.g., Kolers, 1978; Kolers & Gonzales, 1980; etc.), while other studies have suggested that bilinguals have one common memory for both languages (e.g., Lopez & Young, 1974; McCormack, 1977; etc.). The former view is called the independence hypothesis and the latter the interdependence hypothesis. Over the last decade, however, the debate on whether bilinguals have a common or separate memory storage for their two languages has abated. Instead, Paradis (1978) proposed a model in which both of the bilingual's languages are *differentially* connected to the same conceptual-experiential store. In addition, Paivio & Desrochers (1980) have suggested that the bilingual's two linguistic systems are interconnected, but function independently. They have proposed a *bilingual dual coding model*, which was inspired by the dual coding theory that Paivio (1971) originally used to explain cognitive and language processing in monolinguals.

The dual coding theory (Paivio, 1971) assumes that cognitive activity is mediated by two symbolic systems, one specialized for processing verbal information and the other for nonverbal information. According to the theory, these two representational systems are presumed to be interconnected, but capable of functioning independently. The dual coding theory extended to bilingual memory (Paivio & Desrochers, 1980; Paivio & Begg, 1981) assumes that there are direct connections between the two language systems as well as a non-verbal imagery system capable of functioning as a shared conceptual system for the two languages. In the bilingual dual coding model, these three systems are independent and autonomous from each other, but connected at the referential level.

Based on the dual coding theory, Paivio (1990) describes bilingual mental functioning as necessarily occurring along two separate dimensions, which are also functionally interconnected:

> Persons who have mastered two (or more) languages must have two distinct representational subsystems of some kind, since they are able to deal separately and meaningfully with different acoustic and response patterns. Moreover, bilinguals must have some way of switching efficiently from one linguistic code to the other in bilingual context. This means that bilingualism entails productive representational systems corresponding to the units and structures of each language, and functional interconnections between them. (Paivio, 1990, p.239)

This view is relatively uncontroversial among cognitive theorists interested in bilingualism (Paivio, 1991). A bilingual dual coding model can not only incorporate general theories of human language and cognition in current linguistics and cognitive psychology (e.g., universal grammar: Chomsky, 1976; and connectionist model: Rumelhart, 1989), but can also explain controversial findings of previous research on bilingual memory (i.e., the debate on whether bilinguals have one common memory store for their two languages or a separate memory store for each language).

Hamers & Blanc (1989) in their revision of the bilingual dual coding model agreed with Paivio & Desrochers (1980) that, to "explain the functioning of bilingual memory, imagery is an important component of verbal memory (p.105)". However, Hamers & Blanc (1989) differed in suggesting that there is a *common semantic memory* which is "fed by the two separate verbal channels, each with a surface memory device (p.105)", whereas in the original bilingual dual coding model proposed by Paivio & Desrochers (1980) semantic memory was language-specific. Hamers & Blanc's model (1989) can better explain the existing evidence and their approach is consistent with recent trends in

psycholinguistics and information processing, although the idea of bilingual dual coding approach originated with Paivio & Desrochers (1980).

Although a bilingual dual coding model can adequately explain memory processing in bilinguals, there is a lack of research on bilingual memory in the sense that most of previous research has been conducted with balanced bilinguals, who could speak both of their languages fluently. Not much attention has been paid to memory processing in *unbalanced bilinguals* who can speak one language fluently, but are in different stages of developing proficiency in another language. It would be interesting to look at memory processes in unbalanced bilinguals and to examine whether a dual coding theory could be extended to unbalanced bilinguals. Also of importance is the *linguistic relationship* between the two languages of the bilingual, which means whether the linguistic features of the two languages of the bilingual are similar (e.g., English vs. German or Spanish vs. Portuguese) or different (e.g., Chinese vs. English or Korean vs. French). The important question is the extent to which the linguistic relationship between a bilingual's two languages influences memory processing.

In this dissertation, bilingual memory processing was examined with special attention to two features of bilingualism that have not been the topic of much previous research. The first feature has to do with a bilingual's proficiency level in each language. It is generally conceded that bilingual processing is more uniform for each language when the bilingual individual possesses a high degree of proficiency in both languages. If the proficiency level of two languages is not equal, does language processing in unbalanced bilinguals differ from that of balanced bilinguals? Hereafter, *degree of bilinguality*[1] will refer to the status of attained proficiency in two languages. In this dissertation, a central question had to do with how bilinguals who differed along a continuum of bilinguality processed information in each of their linguistic systems. Thus, three different groups of bilingual subjects were compared in this study: balanced bilinguals, unbalanced bilinguals dominant in one language, and another group of unbalanced bilinguals dominant in the opposite language.

The second feature of interest in this dissertation was the linguistic relationship (linguistic similarities and differences) between the two languages of the bilingual. For example, English is phonologically, morphologically, and syntactically very different from Korean while English and Spanish share many structural similarities because they are both

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[1] According to Hamers (1981), the definition of bilinguality is the psychological state of an individual who has access to more than one linguistic code as a means of social communication.

Indo-European Languages. Further, Korean is both semantically and pragmatically very different from English whereas Korean is more similar to Japanese. The semantic and pragmatic components of a language are strongly influenced by the cultural similarities of the countries where the languages are spoken. This comes from the question of linguistic relativism, which is the idea that languages differ in how they carve out segments of reality (Whorf, 1956). Thus, Korean is semantically closer to Japanese than to English because Korean and Japanese share many cultural features. Although there is little empirical information[2] to evaluate how linguistic similarities and differences between the two languages of the bilingual influence mental processing, this consideration is very meaningful, but a neglected area of study in bilingual memory research. Therefore, in this dissertation, bilingual memory processing was compared using two different bilingual combinations: Korean-English bilinguals versus Spanish-English bilinguals.

The purpose of this dissertation was then to examine the following research questions: (1) Are there differences in bilingual memory processing depending on a respondent's degree of bilinguality?; and (2) Does linguistic similarity and/or difference between the two languages of the bilingual influence memory processing? The research studies to be described in this dissertation were designed to examine these research questions from the perspective of the bilingual dual coding model (Paivio & Desrochers, 1980; Hamers & Blanc, 1989).

In Chapter 2, I reviewed the theoretical and empirical literature on bilingual memory. Of importance is how bilingual memory has been conceptualized with special attention to research conducted to test the dual coding framework. Following the review, I described, in Chapter 3, a study that was conducted to test the dual coding model with Korean-English unbalanced bilinguals (Study I: A Test of the Dual Coding Model for Unbalanced Korean-English Bilinguals). Based on the findings of Study I and insights gained from the study, I designed a more elaborate study to examine memory representation in bilinguals. In order to conduct this elaborate bilingual memory study, however, an intermediate step was required which consisted of developing an appropriate set of stimulus items which would be necessary for my bilingual memory study. Thus I conducted a second study (Study II: Selection of Stimulus Items for Bilingual Memory Research) which is described in Chapter 4. Study II shows how I scaled a set of stimulus items that would subsequently be used in the proposed bilingual memory recall study. Finally, I described an elaborated study (Study III: Bilingual Memory Representation:

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[2] To review the literature on this topic, see Genessee, 1988; Hoosain, 1991; and Chen & Tzeng, 1992.

Further Application of the Bilingual Dual Coding Model to Korean-English and Spanish-English Bilinguals with Varying Degrees of Bilinguality), which examined memory representation in two different bilingual combinations (Korean-English and Spanish-English bilinguals) with a special attention to the degree of bilinguality based on the respondents' proficiency level in their two languages.

CHAPTER 2

LITERATURE REVIEW

Cognitive psychologists have studied mental processes involving knowledge and language, by focusing almost exclusively on monolinguals (Anderson, 1983, 1985; Johnson-Laird, 1983; Posner, 1989). In contrast, the mental process of the bilingual individual has received relatively little attention over the last four decades. In this chapter, the literature on bilingual memory research will be reviewed to trace how researchers have sought to conceptualize and understand bilingual memory.

The literature on bilingual memory can be divided into three different periods based on conceptual and methodological emphases (Paivio, 1991). The first period focused on the *language learning context* of the bilingual individual and developed a distinction between different bilingual types: compound versus coordinate bilinguals (Weinreich, 1953; Ervin & Osgood, 1954). The next period emphasized *bilingual memory storage* based on two opposing theoretical grounds: interdependence versus independence hypotheses (Kolers, 1963). In this period, controversial findings from a great deal of research produced two different memory models: common versus separate memory storage models. The last and current period emphasizes *general theories of language and cognition* (an extension to the universal grammar of Chomsky, 1976, 1981, 1986; a dual coding theory by Paivio, 1971, 1990; a connectionist model by Rumelhart, McClelland, & the PDP Research Group, 1986) that can also accommodate bilingual phenomena.

I begin with an overview of the literature of the first two periods in bilingual memory research. I then review general theories of cognitive and linguistic processes, and explain mental representation. This is followed by a summary of the major constructs of the dual coding theory (Paivio, 1971), which is later applied to bilingual memory studies (Paivio & Desrochers, 1980; Paivio & Begg, 1981). I introduce current research trends in bilingual memory studies by explaining the *bilingual dual coding model.* Then I review the available published articles that seek to test some aspect of the bilingual dual coding model. I conclude the literature review on bilingual memory by offering a revised dual coding

model advanced by Hamers & Blanc (1989). Finally, I show how this revised version of the bilingual dual coding model incorporates the major features of current cognitive theories and accommodate existing research findings.

Historical Overview of Research on Bilingual Memory

Research on Different Bilingual Types

The compound-coordinate distinction in bilinguals was first introduced by Weinreich (1953). Weinreich believed that different kinds of relationships could hold between the bilingual's linguistic systems (e.g., words) and their conceptual systems (e.g., referents). In compound bilingualism, the relationship between words and their referents could be the same in the two languages of the bilinguals. Thus compound bilinguals were presumed to have good control of their two languages, and these are connected to a single, fused conceptual system. In coordinate bilingualism, on the other hand, the relationship between words and their referents in one language could be different from that of the other language. Thus coordinate bilinguals were assumed to function like unilinguals in each of their languages, since the two conceptual systems acquired through each language are clearly differentiated. What Weinreich really meant was that the compound or coordinate distinction constituted a different state of bilingualism and thus both states could occur in a bilingual individual depending on the language learning context.

On the other hand, Ervin and Osgood (1954) introduced the compound-coordinate distinction in terms of individual differences. They proposed a hypothesis that bilinguals could be divided into compound and coordinate types on the basis of the degree to which translation equivalents in the two languages have the same or different meanings: same for compounds, different for coordinates. This hypothesis implies that bilinguals do not all organize verbal information in the same way, and that the two languages function more independently in the case of coordinate than compound bilinguals. Whether this distinction occurs within a bilingual individual as Weinreich explained or is a difference between two types of bilinguals as Ervin and Osgood suggested, the most important point is that the compound-coordinate distinction depends on similarities or differences in *acquisition contexts*. At any rate, most of the empirical studies of compound and coordinate bilingualism had been done under the individual difference framework.

During the first phase of bilingual memory research, researchers refined and operationalized the compound/coordinate hypothesis by means of various behavioral and neuropsychological studies. Lambert, Havelka, & Crosby (1958) examined the effect of language-acquisition context on bilingual organization using the *semantic differential method.* They demonstrated that separate acquisition contexts for each language led to more functional separation between the two languages of the bilingual. They used questionnaires and other sources of information to classify French-English bilinguals as compound or coordinate according to differences in acquisition contexts. They found that French-English bilinguals classified as having learned their two languages in separate contexts, as compared to those who had learned them in what they called "fused" contexts, showed greater differences in semantic differential ratings and more associative independence for translation-equivalent words. This was the first paper to show evidence that two languages could be more or less separate and functionally independent, depending on how they were learned.

Using a neurological point of view, Lambert & Fillenbaum (1959) proposed a representational substrate for the compound-coordinate distinction. They suggested that "coordinate bilinguals should have more functionally separate neural structures underlying their languages than should compound bilinguals" (p.29). They tested their hypothesis using data from polyglot aphasics reported in the literature and from cases of such aphasics obtained from several hospitals and rehabilitation centers in Montreal. Extending the neuropsychological distinction between compound and coordinate bilinguals, Genesee and his collaborators (1978) classified "early" and "late" bilinguals depending on the age of becoming bilingual. They monitored the levels of electrical activity in the two hemispheres of the brain and suggested that the early bilinguals showed greater use of their left hemisphere, while late bilinguals evidenced greater right-hemisphere involvement.

There have been also a large number of experiments to test the compound-coordinate distinction with different techniques (e.g., *semantic satiation* and *semantic generalization*: Lambert & Jakobovits, 1960; Jakobovits & Lambert, 1961; 1967; *association technique:* Lambert & Rawlings, 1969). Generally speaking, these experiments demonstrate that compound bilinguals have a higher degree of interdependence in the organization of their two languages than coordinates. However, this compound-coordinate distinction is not always evident. Some studies did not find this compound-coordinate difference (Dillon, McCormack, Petrusic, Cook & Lafleur, 1973; Arkwright & Viau, 1974). Therefore, Lambert & Moore (1966) said that compound bilinguals may also possess dissimilar semantic networks for a word in one language and its translation

equivalent. On the other hand, researchers (Kolers, 1963; Clark, 1978; Hammoud, 1982) have shown that for the same subject the degree of semantic overlap in two languages is not the same for concrete and abstract words. Research findings provided evidence that bilingual subjects have greater compound organization for concrete words and a more coordinate system for abstract words.

Based on research findings, it is reasonable to conclude that late bilinguals have a coordinate organization of their two languages, however, not all early bilinguals are compound. A real compound bilingual can exist only when the language acquisition histories are very similar (may be identical) for both languages. Thus, the compound-coordinate distinction must be used with caution since there are individual differences which preclude clear categories. However, language learning histories and contexts have proven to be important factors in understanding the way in which bilinguals organize linguistic information in memory. Therefore, it is more convincing to say that the compound and coordinate distinction in bilinguals can be found in any speaker of two languages depending on the context in which each term or expression has been learned. This view is close to how Weinreich (1953) originally coined these terms.

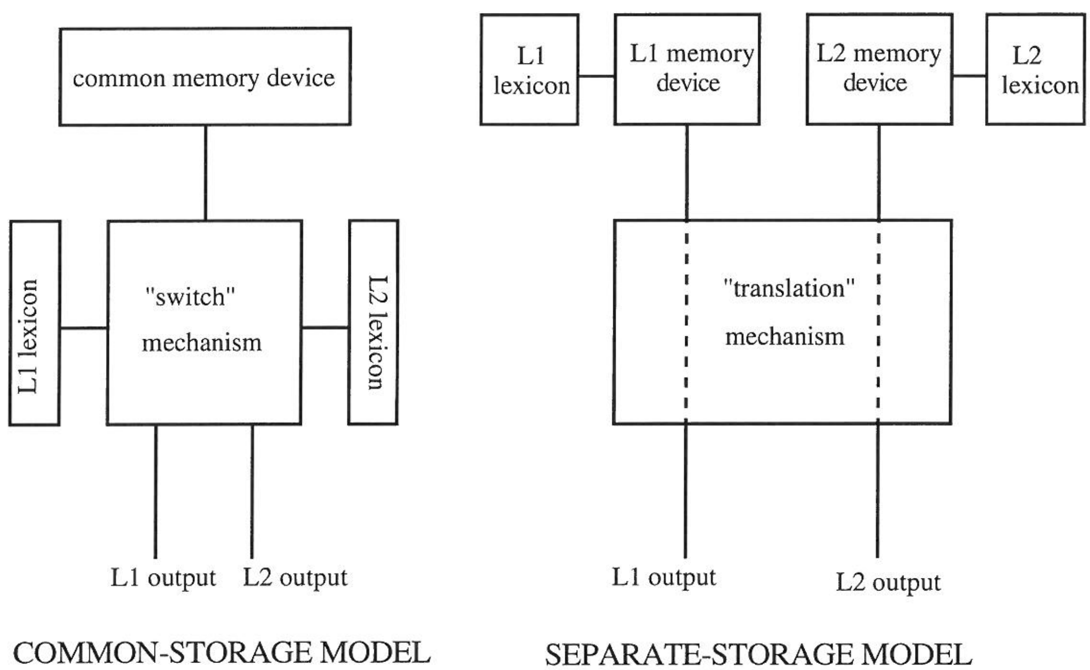
Research on Bilingual Memory Storage

During the next phase of bilingual memory research, a debate over the nature of representation of words in the bilingual's lexicon has dominated bilingual linguistic memory studies. Kolers (1963) was the first investigator to place the debate between the *interdependence* versus *independence* of the bilingual's two languages in the context of information processing approaches to human cognition. Based on Kolers' initial ideas about the bilingual's memory system, two competing hypotheses were advanced, and based on each of the hypotheses, two competing bilingual memory models were proposed: the *common storage model* under the interdependence hypothesis and the *separate storage model* under the independent hypothesis (see Figure 2-1).

According to Hamers & Blanc (1989), the interdependence hypothesis states that bilingual memory is a single system in which information is stored as a complex set of attributes or tags which enables the bilingual to store non-semantic information such as modality, frequency, spatial and temporal aspects, and type of language (e.g., English, Korean). Language is then one of these tags through which the common store taps into

[Figure 2-1]

Common-Storage vs Separate-Storage Model of Bilingual Memory



Source: Hammers & Blanc (1989). Bilinguality & Bilingualism, Cambridge University Press.

two lexical systems via a *switching mechanism*. On the other hand, the independence hypothesis holds that bilingual memory is represented by two functionally independent storage and retrieval systems that are in contact with each other via a *translation mechanism*.

Both models postulate the existence of a *mechanism* which permits the bilingual to switch from one linguistic system to the other. They differ from each other in where they locate this mechanism during processing. In the common storage model, this switch is situated before semantic memory (see Figure 2-1). Here the switching mechanism is set to whichever language is being processed and information is sent to a common memory store. In the separate storage model, the switch is placed at a "deeper" level and information in each language is stored separately, unless it is required in the opposite language and is thus translated via the translation mechanism.

Controversial findings have been reported to support either of two hypotheses. If the independence hypothesis is correct, balanced bilinguals should react as monolinguals in both their languages, independently from what they learned in their other language. For example, bilinguals either respond differently in their two languages or fail to transfer from one language to the other. Evidence for supporting the separate storage model has been found in studies using association tasks (Kolers, 1963; 1968; Lambert & Moore, 1966; Dalrymple-Alford & Aamiry, 1970), free recall tasks (Tulving & Colotla, 1970; Kolers & Gonzales, 1980), language tagging (Kolers, 1965; Lambert, Ignatov & Krauthamer, 1968; Saegert, Hamayan & Ahmar, 1975), and a repetition-lag procedure (Glanzer and Duarte, 1971).

On the other hand, if the interdependence hypothesis reflects a common memory store, it is supported by evidence indicating that intralingual behavior does not differ from interlingual behavior in bilinguals. Empirical support for the common storage model has been found in studies investigating recall (Young & Saegert, 1966; Nott & Lambert, 1968; Kintsch & Kintsch, 1969; Liepmann & Saegert, 1974; Lopez & Young, 1974), recognition (Young & Navar, 1968), paired association (Lopez, Hicks & Young, 1974) and investigations involving the Stroop color-word task (Dyer, 1971; Preston & Lambert, 1969), and studies using processing time (Magiste, 1979; 1982).

Kolers originally favored the independence view of bilingual memory because of his own findings on transfer of practice and associative performance. Kolers (1963) had subjects associate to words in one language and their translation equivalents in the other language. The common store hypothesis predicts a high level of common associations to L1 and L2 translation equivalents; the separate store hypothesis, however, implies a low level of common associations across languages. Kolers found that the proportion of common responses to translation equivalents was generally low but varied somewhat with word class. (The proportions were .23 for concrete nouns, .14 for abstract nouns, and .10 for emotion-laden words.) Kolers interpreted his results as supporting the independence position. Interestingly, he later qualified this by suggesting that concrete information is stored partly in a common form because of the overlapping way in which referents to concrete nouns are manipulated across different languages. This differs from abstract information which is more closely bound to the language in which it is stored in memory. We can note that Kolers' reliance on word referents in his analysis parallels Lambert, Havelka, and Crosby (1958)'s use of similarities and differences in referential experience in their analysis of compound and coordinate bilingualism.

Based on the reviews of the literature, McCormack (1977), McLaughlin (1978), and Dornic (1980) all concluded that the weight of the evidence supported the common store hypothesis. On the other hand, Kolers (1978) advocated the separate-storage model on the grounds that empirical evidence using a variety of tasks such as word association, free recall, and recognition tasks could not be explained by the common-storage model. In a review of the literature on information processing in bilinguals, Hamers and Blanc (1989) concluded that the controversy between the two opposing points of view was still very much an open question and that existing data could be marshaled to support either position. Similarly, Grosjean (1982) stated that perhaps the question of independence versus interdependence was fated for mixed findings from the beginning. On the other hand, Hakuta (1986) stated that bilinguals have a common store for both languages at some level, but that the two systems must be independent at another level. Hakuta's point is that bilinguals can transfer knowledge across two languages with relatively little interference between languages.

Up to this point, I have reviewed the first two periods of development in bilingual memory research. Bilingual research in the current period emphasizes more general cognitive theories that differ in their representational assumptions from previous theories. I will first review the current development of human cognitive processes related to language processing and mental representation. I will then continue reviewing the bilingual literature in the current period.

General Theories of Cognition and Language

Cognitive Processes of Human Knowledge on Language

Of all cognitive abilities, the use of language is the most impressive. When Chomsky (1980) proposed various "mental organs", he came up with a series of characterizations of language behavior, which seem quite unlike other cognitive systems. He stated that language is a unique system within human cognition. The human knowledge about language has been studied by both linguists and psychologists, but the main emphasis differs between these two groups of scholars. The linguist is concerned with characterizing our linguistic competence, which is our abstract knowledge about the

structure of language (Chomsky, 1968). In contrast, the psychologist is concerned with linguistic performance, which is how we actually use language.

According to Larsen-Freeman (1991), the linguist's concern about cognitive processes of human knowledge on language is based on a nativist perspective, which means that learning depends upon a significant, specialized *innate* capacity for language acquisition. The concept of Universal Grammar (Chomsky, 1976) was introduced to explain the internal structure of the part of the human mind relevant to language learning. The main idea of Universal Grammar (UG) is that all human beings share part of their knowledge of language regardless of which language they speak: UG is their common inheritance. The UG theory holds that the speaker knows a set of *principles* that apply to all languages, and *parameters* that vary within clearly defined limits from one language to another (Chomsky, 1981; 1986). Therefore, acquiring a language means learning how these principles apply to a particular language and which value is appropriate for each parameter (Cook, 1988).

Unlike the linguist's perspective, a group of psychologists explains language processing from a behavioristic perspective (Larsen-Freeman & Long, 1991) in a sense that the learner's experience is considered more important than innate capacity. One of the recent prominent theories in understanding cognitive processes is Connectionism: Parallel Distributed Processing (Rumelhart, McClelland, & the PDP Research Group, 1986). The main idea of a connectionist model is that learning is held to consist of the strengthening of connections in complex neural networks and that the strength of their connections is determined by the frequency of patterns in the input. PDP theorists have built computer models of human cognition based on what is known about the structure of the human brain. As the input is encoded, the computer reorganizes itself to reflect the new statistical relationship present in the input. After being presented with a number of correctly matched input and output patterns, the computer is presented with a novel set of items to see how it generalizes beyond what it has received as input (Sokolik, 1989). What results is performance that looks like rule-governed behavior, but which is simply a reflection of the connections formed on the basis of the relative frequency of patterns in the input.

Mental Representation

In cognitive psychology, we are interested in the structure of human memory. However, no one knows exactly the way in which humans *organize* linguistic knowledge.

We assume the organization of linguistic information in memory by inferring from the tests of linguistic memory performance. Among the various kinds of linguistic performance, some cognitive psychologists are interested in language use from an *information processing perspective*. A cognitive psychologist with this orientation studies how linguistic information is processed in human memory (i.e., how to store, organize, and retrieve this information). In addition, the psychologist is interested in how knowledge is represented in human memory. The concept of *representation* is therefore very important. Concerning the relationship between memory organization and its representation, Brewer & Pani (1983) states that human memory is organized in terms of the types of input and types of acquisition conditions, and memory representation can be proposed in terms of the intersections of these two factors. Thus, in the study of memory and cognition, *memory representation* is a central issue.

Palmer (1978) presents an analysis of cognitive representations in which he distinguishes "mental model" that is a *representation* of the "mental world", which is then a *representation* of the "real world". He says that a representational theory should simultaneously be the proper description of both the mental world and the mental model. Johnson-Laird (1983) also explains how mental models *represent* the external world in his analysis of mental representations. Along with mental models and images, he proposed the existence of propositional representations, which he defined as symbols that correspond to natural language. However, he made no reference to the representational role of natural language itself.

In an overview of representational systems, Rumelhart & Norman (1988) classified the focus of research on representational systems into four categories. First, the propositionally based system assumes that knowledge is represented as a set of discrete symbols or propositions, so that concepts in the world are represented by formal statements. Second, the analogical representational system states that the correspondence between the represented world and the representing world is as direct as possible. Third, the procedural representational system claims that knowledge is assumed to be represented in terms of an active process or procedure. The final view is that knowledge in memory is not represented at any discrete place in memory. Instead, it is distributed over a large set of representing units - each unit representing a piece of a large amount of knowledge.

Then, what is the relation between mental representation and memory processing? Paivio (1990) summarizes its relationship as follows:

> The representation-process distinction is closely related to the classical distinction between structure and function. The term representation refers to a structural entity on which processes or procedures can operate, whereas process refers to the activities involved in making functional use of the structural information. (p.20)

Rumelhart & Norman (1988) also add one more important aspect of a representation system that must be considered which has to do with the processes that operate upon the representations. The representations within the representing world do not carry their meaning without the assistance of some process that can make use of and interpret the representational structures. Thus, representational systems consist of at least two parts: (1) the data structures, which are stored according to some representational format, and (2) the processes that operate upon the data structures.

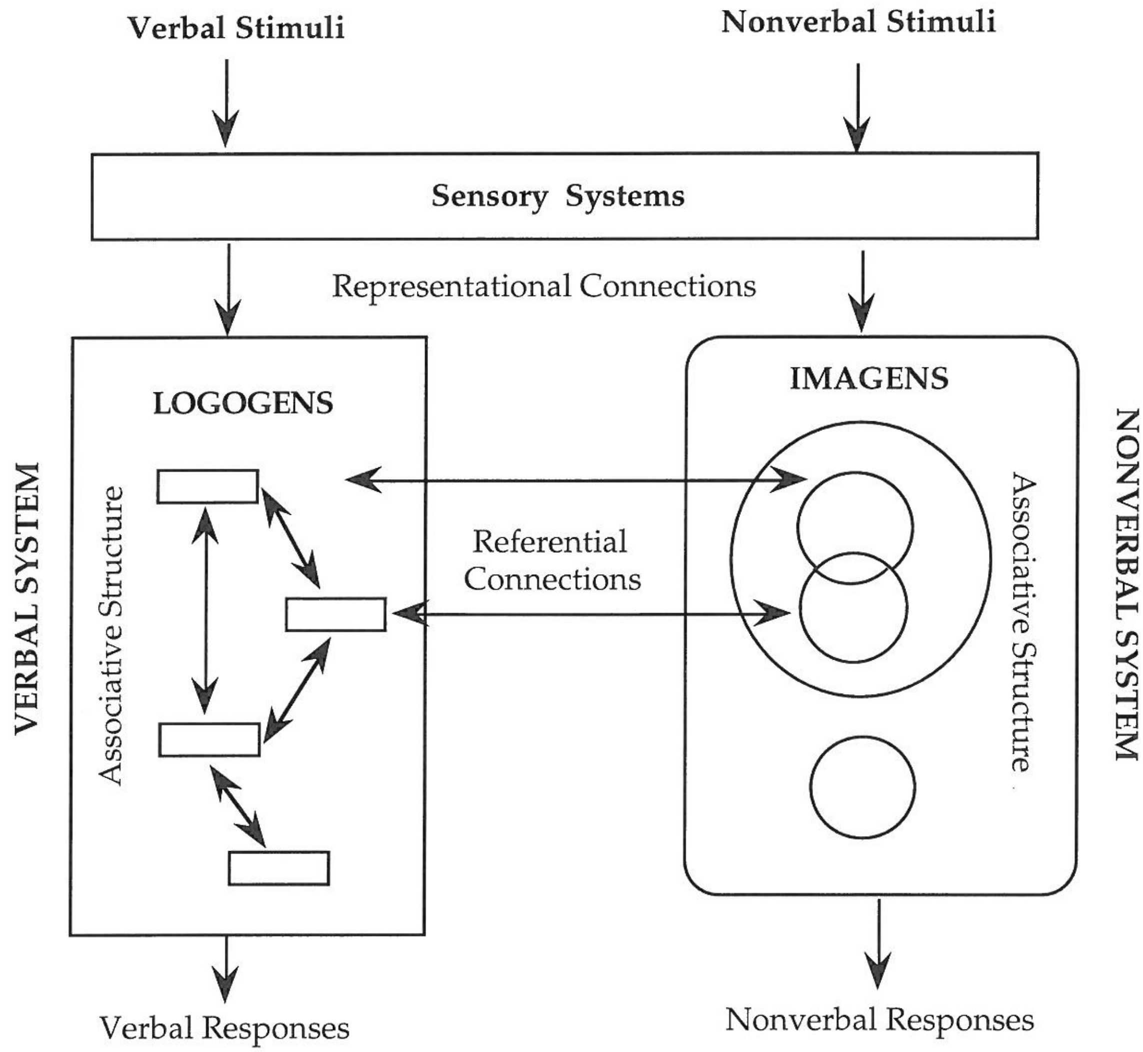
The Dual Coding Theory

The dual coding theory is based on the assumption that memory and cognition are served by two separate symbolic systems, one specialized for dealing with verbal representation (*logogens*) and the other with nonverbal representation (*imagens*). The two systems of representations are presumed to be interconnected, but capable of functioning independently. Paivio (1990) summarizes the general view on which the dual coding theory is based as follows:

> ...... the general view that cognition consists of the activity of symbolic representational systems that are specialized for dealing with environmental information in a manner that serves functional or adaptive behavioral goals. This view implies that representational systems must incorporate perceptual, affective, and behavioral knowledge. Human cognition is unique in that it has become specialized for dealing simultaneously with language and with nonverbal objects and events. Moreover, the language system is peculiar in that it deals directly with linguistic input and output (in the form of speech or wiring) while at the same time serving a symbolic function with respect to nonverbal objects, events, and behaviors. Any representational theory must accommodate this functional duality. (p.53)

In the dual coding theory, the most general assumption is that there are two classes of phenomena handled cognitively by *separate subsystems*; one specialized for the representation and processing of information concerning nonverbal objects and events, the other specialized for dealing with language. As we can see in Figure 2-2, nonverbal

[Figure 2-2] Dual Coding Model



Source: Paivio, A. (1990). Mental Representations: A Dual Coding Approach. Oxford Psychology Series No 9. New York: Oxford University Press.

information such as mental images (various sensory images) is stored in a nonverbal symbolic subsystem and linguistic information in the verbal subsystem.

The two systems of representation are different from each other by the nature and the organization of their units, the way they process information and the function they perform in perception, language processing, and cognition. The idea of separate subsystem means that the two systems are assumed to be structurally and functionally

distinct. Structurally, they differ in the nature of representational units and the way the units are organized into higher order structures. Functionally, they are independent in the sense that either system can be active without the other or both can be active and operate in parallel. At the same time, they are functionally interconnected so that activity in one system can initiate activity in the other.

Dual coding theory entails assumptions of three levels of processing (see Figure 2-2). First, *representational processing* involves the independent activation by a stimulus. Thus, words activate verbal representation, whereas objects or their pictures activate imagery representation. Second, *referential processing* refers to activation of representations in one system by the other through their interconnections. For example, naming an object, generating a mental image for a word are all referential responding. At a third level, *associative processing* refers to connections between linguistic units and between images in each system. The idea of associative processing is similar to the idea of Connectionism (Rumelhart, McClelland, & the PDP Research Group, 1986).

The two systems of the dual coding model are presumed to be interconnected at the referential level, but capable of functioning independently. Interconnectedness means that representations in one system can *activate* those in the other, and independence implies that nonverbal and verbal memory codes should have an *additive effect* on recall. Paivio & Csapo (1973) clearly showed such an additive effect. In their study of free recall, they found that stimuli presented in pictures were recalled more often than stimuli presented verbally.

Bilingual Dual Coding Model

Paivio and Desrochers (1980) suggest that the bilingual has two verbal representations, one for each language, in addition to a representation in the imagery system. These three systems are independent and autonomous from each other but are interconnected at the referential level. Actually, the two verbal representational systems function independently from each other, but there is one memory in imagery which is in constant interaction with the two verbal systems. *Interconnectedness* means that representations in one system can activate those in the other, so that, for example, pictures can be named and images can occur for words. *Independence* implies, among other things,

that nonverbal and verbal memory codes, aroused directly by pictures and words or indirectly by imagery and verbal encoding tasks, should have *additive* effects on recall tasks.

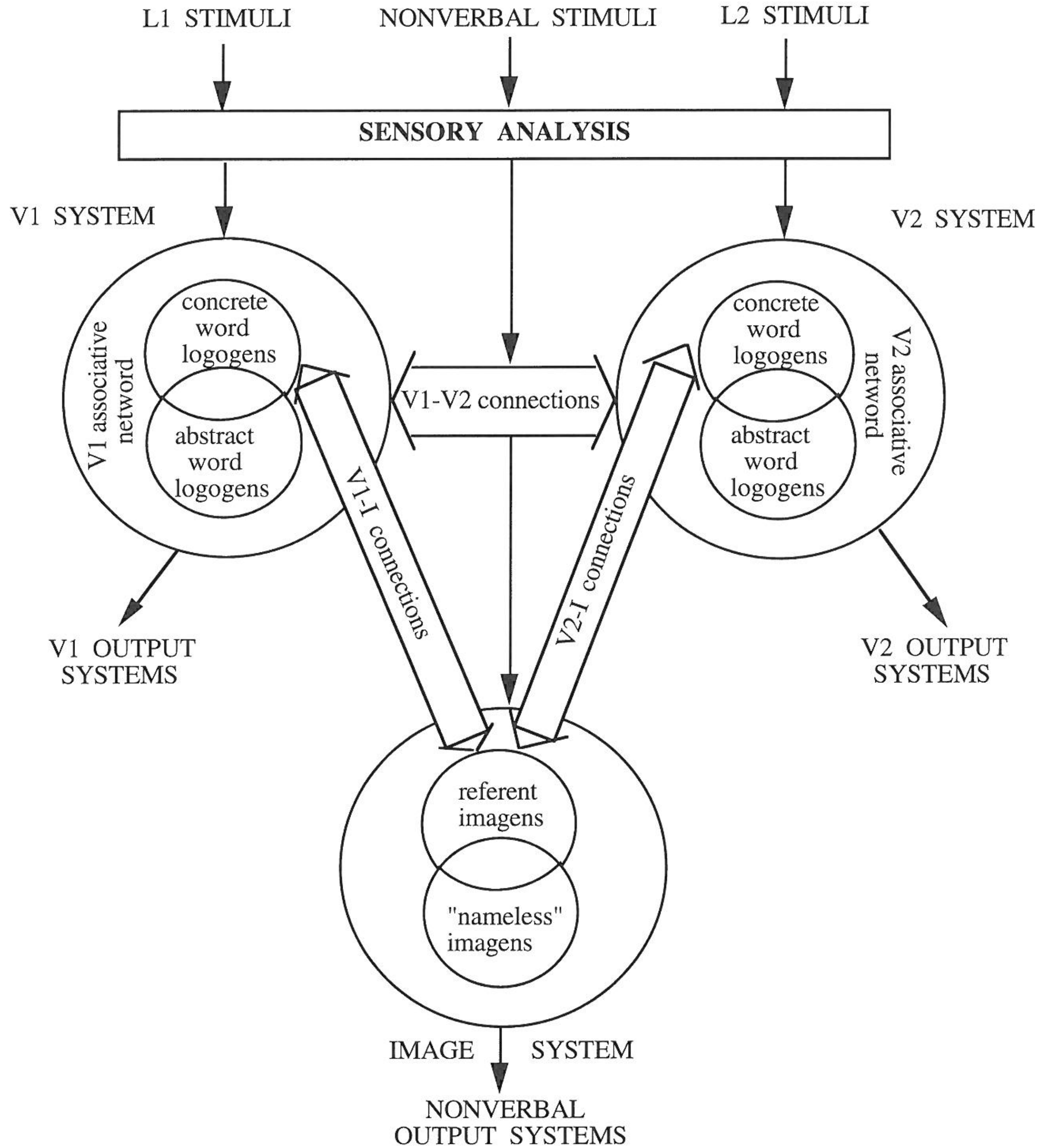
In 1980, Paivio & Desrochers extended the dual coding theory to include bilingual memory. In their extension, they stated that bilinguals have two verbal representational systems, one for each language, in addition to a representation in the imagery system (see Figure 2-3). These three systems are functionally independent and autonomous from each other, but are interconnected at the referential level. In the bilingual version of the dual coding model, we see the three levels of processing: representational, referential, and associative connections, which I described earlier in the explanation of the original dual coding model.

In the dual coding theory, the nonverbal imagery system is assumed to be functionally independent of both verbal systems. The assumption implies that bilinguals can perceive, remember, and think about nonverbal objects and events without the intervention of either language system and, conversely, that they can behave or think verbally without constant input from the nonverbal system. On the other hand, the systems are at the same time functionally interconnected at the referential level, so that verbal activity in either language system can be influenced by the imagery system and vice versa.

It is assumed further that the two verbal systems (V_1 and V_2) in Figure 2-3 corresponding to the bilingual's two languages (L_1 and L_2) have referential interconnections to the image system (V_1-I and V_2-I connections) that are partly shared and partly independent. That is, the verbal translation equivalents in L_1 and L_2 may or may not activate the same nonverbal representational information, depending on the way the two languages have been acquired. This assumption explains the familiar idea that translation equivalents do not necessarily have identical referential meanings.

A dual coding approach to bilingual memory representation was first attempted by Paivio & Desrochers (1980). They claim that among the "independence-interdependence" controversy of bilingual memory, the dual coding theory incorporates a version of the independence view of bilingual memory because the independence hypothesis predicts that bilingual coding should have an additive effect on recall probability while the interdependence hypothesis predicts that bilingual and unilingual coding results in equivalent recall. However, the dual coding model also includes a common representation system that provides a basis for interpreting some findings that appear to support the

[Figure 2-3] Bilingual Dual Coding Model



Source: Paivio, A & Desrochers, A. (1980). A dual coding approach to bilingual memory. Canadian Journal of Psychology, 34, 390-401.

interdependence hypothesis. Overall, the model provides a comprehensive account of both sets of findings summarized above and has unique implications that go beyond those that arise from the independence or interdependence positions separately considered.

The most direct support for dual coding theory comes from evidence of *additive effects* of verbal and nonverbal memory traces on *recall performance* (for the review in monolinguals, see chapter 8 in Paivio, 1990). There are not many bilingual studies using a dual coding framework. The first attempt to test the implications of the bilingual dual coding theory consisted of two experiments by Paivio & Lambert (1981). In their study, French-English bilinguals were required to encode words in different ways prior to a recall test. In one experiment, the subjects saw a mixed list of pictures, French words, and English words to which they responded by writing the English name of each picture, translating the French words into English, and simply copying the English words they had written down. The subjects were unexpectedly asked to recall the list of English words they had written down. The second experiment reversed the encoding and recall tasks in that the subjects were shown only English words and, in response to encoding cues, they imaged and quickly sketched the referents of one-third of the words, translated one-third into French, and copied the remaining third. Then they were asked to recall the English stimulus words they had been shown. In both experiments, therefore, the subjects recalled English response words they had generated by different encoding processes or stimulus words they had encoded in different ways.

The results of both experiments showed an identical pattern, with recall increasing sharply from the copy condition, to translation, to the verbal-nonverbal coding condition. Recall was about twice as high for translated as for copied items, suggesting that the bilingual verbal encodings were at least additive in their effect. The further large increase from the bilingual to the verbal-nonverbal encoding condition is consistent with the dual coding assumption that verbal and nonverbal components are independent and that the nonverbal component is mnemonically stronger than the verbal one. In the free recall task, the ratio of recalled items according to the mode of stimulus was approximately 3 : 2 : 1 (i.e., imaged : translation : copy).

A few other researchers of bilingual memory such as Arnedt & Gentile (1986), Vaid (1988), and Paivio, Clark, & Lambert (1988) support the dual coding hypothesis in bilinguals by using a free recall task. Especially, Arnedt & Gentile (1986) suggests that the language acquisition history influences the pattern of recall such that subjects who learned the second language in the traditional classroom environment had higher recall of translated

items than those who learned it through more exposure to the second language in natural contexts. However, in their study they did not find statistically significant difference in recall.

Level of processing has been questioned in bilingual research. For example, Vaid (1988) questioned whether translated words could be better recalled than copied ones because translation requires a deeper level of processing than copying and it is natural that the more deeply processed information must be better recalled. Vaid (1988), however, confirmed the dual coding theory in bilinguals over the level of processing by using a synonym condition (deeper level of processing than copying a word). She supported the dual coding hypothesis on bilingual memory representation by showing that both imaged and translated words still resulted in better recall than synonyms.

Paivio, Clark, & Lambert (1988) extended Glanzer & Duarte's (1971) bilingual repetition lag experiment by adding variation in word concreteness and within-language synonym repetitions to the design. They replicated the Glanzer & Duarte findings in that the lag effect was attenuated for bilingual repetitions. In addition, several new findings supported specific predictions from bilingual dual coding theory. First, in the case of abstract as well as concrete words, bilingual repetitions had additive (statistically independent) effects on recall at zero lag. This observation not only supports the independence hypothesis of bilingual memory, but also allows one to assign the independence specifically to the two lexical systems rather than to some unspecified semantic systems. Second, synonym repetitions also showed the attenuated lag effect but the effect of repetition was generally weaker than in the case of bilingual repetitions, as expected from the assumption that between-language associative relations are more constrained or less diffuse than within language relations. Finally, semantic repetitions (bilingual and synonym) were more effective with concrete words than with abstract words, presumably because recall was augmented by the availability of shared images for concrete semantic equivalents.

Paivio's work has also been extended to include an interpretation of compound and coordinate bilingualism by using the dual coding model. In compound bilinguals, a stimulus word in one language activates the same image as its translation equivalent in another language. So, there must be an identical or very similar referential connection to the imagery system. In contrast, in the case of a coordinate bilingual, a stimulus word in one language activates a very different image from the translation equivalent in the other

language. Thus there must be different, or relatively different sets of referential connections in the imagery system.

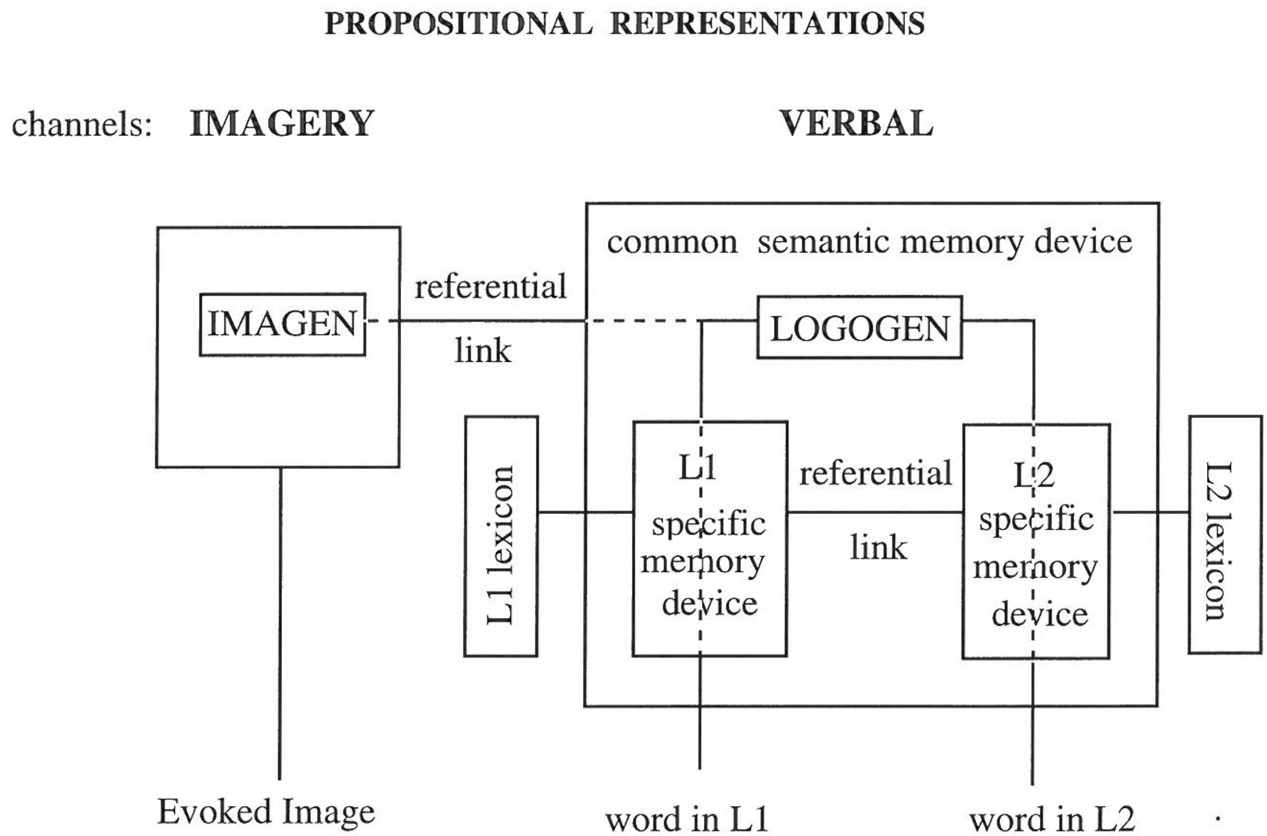
In discussing the compound-coordinate distinction, it is important to recognize that whatever differences emerge are more a matter of degree. There is no "pure" case of one type of bilingual. Even at the lexical level in the same bilingual individual there may be different referential connections between systems depending on the "context" where the person learned the lexical stimuli in question. That is, different associative patterns are determined by the linguistic and nonlinguistic experiences that the bilingual has been exposed to during language learning.

In sum, dual coding theory in bilinguals is a specific version of the independence approach to bilingual cognition, but it also includes a common representational system that provides a basis for interpreting some findings that appear to support the interdependence hypothesis. This model is a good alternative to resolve the controversy between the common storage and the separate storage models. Overall, the dual coding model provides a comprehensive account of both sets of findings and has unique implications that go beyond those that arise from the independence or interdependence positions considered separately.

Revised Bilingual Dual Coding Model

Hamers and Blanc (1989) state that the dual coding model offers a promising alternative theoretical approach to earlier speculation of common versus separate memory stores in bilinguals. They proposed a model that was revised from the original bilingual dual coding model (Paivio & Desrochers, 1980). In this revised model (see Figure 2-4), Hamers and Blanc (1989) suggest that in a verbal representational system there is a *common semantic memory* that is *not* language-specific, which differs from Paivio & Desrochers (1980) who proposed that semantic memory was language-specific. Hamers and Blanc state that the bilingual's two verbal channels "join in a common semantic store and there is a referential link between imagery and the totality of the verbal representation structure" (p. 105). Hamers & Blanc (1989) explain their revised model of a bilingual's dual coding theory as follow:

[Figure 2-4] **Revised Bilingual Dual Coding Model**



Source: Hammers & Blanc (1989). Bilinguality & Bilingualism, Cambridge University Press.

> For each verbal channel there is a language-specific memory device which stores stimulus-specific features, such as phonology and perceptual aspects and possibly some limited lexical aspects: these are organized in language-specific logogens. These logogens ..... are further organized into a deeper cognitive level, that of common semantic memory storage, which (is non-language specific) and draws on both languages. This whole structure is (then) related to the imagen through a referential link. (p. 105-106)

This approach can incorporate recent trends in theories of linguistics and information processing. First, postulating a common semantic memory can be considered from the Universal Grammar perspective. Second, introducing various connections between a language-specific memory device and a common semantic memory device can be thought of from a connectionist perspective. Language acquisition is thought to be a

process of inducing rules. The language acquisition mechanisms are believed to include a subsystem - often called the language acquisition device (LAD) - whose business is to discover the rules. I suggest a similar system called a common semantic memory device (CSMD) in my revised version of the bilingual dual coding model which is also innate. In other words, the CSMD can be found in every human being. This system consists of all possible semantic features which can be combined to produce a specific concept in a specific language. Therefore, when a person is exposed to a certain language environment, a specific connection is formed between the language and the common semantic memory system. When another language is introduced to the person, a different connection is formed between the new language and the common semantic memory system. Although connectionist researchers theoretically assume no innate endowment, there must be an initial (and innate) state of the networks they have constructed as observed by Gasser (1990). Therefore, this revised version of the bilingual dual coding model (Hamers & Blanc, 1989) can incorporate ideas of both universal grammar and connectionism.

This revised bilingual dual coding model can also explain the existing findings that the earlier studies produced under the bilingual dual coding theory. Most of the studies on bilingual memory which sought to test the dual coding theory used an incidental recall task after requiring subjects to encode stimuli using three different conditions: copying a word, translating a word into another language, and naming a picture. When the subjects were asked to recall the items they coded after the encoding procedure, verbally coded pictures were more often recalled than were bilingually coded items, which were, in turn, more frequently recalled than copied items. This pattern of findings has consistently been reported in various studies (Paivio & Lambert, 1981; Arnedt & Gentile, 1986; Vaid, 1988; and Paivio, Clark, & Lambert, 1988). The basic assumption of the dual coding theory to explain this pattern of findings is that the bilingual's two language systems along with an imagery system are functionally independent so that there must be an additive effect on recall performance. However, there was no clear explanation for why the image-verbal coding condition produced higher recall than the bilingual coding condition. I believe that the Hamers & Blanc (1989) revised bilingual dual coding model can explain the higher recall in image-verbal coding than in bilingual coding because the two language systems are closely interconnected within a whole language system as can be seen in Figure 2-4. On the other hand, the imagery system is situated apart and functions independently making memory retrieval more efficient.

Summary

In this review of the bilingual memory research, I have taken a historical perspective and divided the review into three distinct periods. The first focuses on language learning context and begins with Weinreich's (1953) distinction between compound and coordinate bilingualism. As this distinction evolved, it became associated with similarities and differences in acquisition contexts (Ervin and Osgood, 1954) and semantic networks (e.g., Lambert and Moore, 1966). This view eventually gave way to theoretical formulations based on interdependence versus independence of a bilingual's two linguistic systems (e.g., Kolers, 1963). The methodological paradigm for this new approach to bilingual memory was information processing which culminated in interesting new investigations of bilingual memory. However, this approach was not much more successful in clearly pointing to how exactly bilinguals process, store and retrieve information in memory.

In the next part of the review, I present an overview of general theories of cognition and language. The focus is primarily on Chomsky's (1976) notion of Universal Grammar and Rummelhart's theory of connectionism (Rumelhart, McClelland, & the PDP Research Group, 1986). These theoretical perspectives are discussed in this review since they present the more current views of mental representation.

From this background emerges Paivio's (1990) dual coding theory and more specifically for this review Paivio and his associates (e.g., Paivio and Desrochers, 1980) extension of the theory to bilingual memory. As I show in the review, the bilingual dual coding model provides a unique way of incorporating ideas from both the independent and interdependent views to bilingual memory. Further, I take up the question of how Paivio and others have extended the dual coding model for bilinguals and how this theoretical approach goes beyond earlier conceptualizations of bilingual memory.

A clear implication from the review of literature presented here is that the bilingual dual coding model merits additional research to confirm its usefulness. One of the possible shortcomings of Paivio's theory and research is that it has largely been confined to the study of English-French or English-Spanish bilinguals. It is not clear how robust the bilingual dual coding model may be with other bilingual language combinations, especially with different languages that do not share similar orthographies. Therefore, in the work to

be presented in this dissertation, I will test the bilingual dual coding model with Korean-English bilinguals.

Another serious issue with current research on bilingual memory research is that investigators have confined their experimental studies to balanced bilinguals. No information is available which provides insights into how bilinguals process, store, and retrieve information from memory in their non-dominant language. Accordingly, in the research to be carried out in this dissertation, I will specifically test the bilingual dual coding model with subjects who are *unbalanced* bilinguals. The question of how unbalanced bilinguals process information in memory is critical since most bilinguals in the world are *not* balanced (i.e., equally proficiency in both languages) bilinguals. Testing the applicability of the bilingual dual coding model with unbala nced bilinguals will offer new insights into bilingual memory representation and processing.

CHAPTER 3

STUDY I: A TEST OF THE DUAL CODING MODEL FOR UNBALANCED KOREAN-ENGLISH BILINGUALS

Research on bilingual memory processes has been done extensively over the last three decades. Problems of most of the previous research on bilingual memory include the fact that these studies have been carried out exclusively with *balanced* bilinguals who have native-like control of two languages and speak both languages fluently. Most researchers have confined their studies to balanced bilinguals, and there has been little research which gives us an understanding of mental processing in *unbalanced* bilinguals. At this time, more might be gained by examining subjects in varying states of bilinguality and consequently who possess possibly different forms of memory organization or representation in each language. In addition, previous bilingual memory research has been done mostly with French-English or Spanish-English bilinguals where both French and Spanish (Romance languages) are etymologically close to English (Germanic language). However, there have not been many studies done with bilinguals whose two languages differ significantly from each other either syntactically or etymologically (e.g., Korean and English).

Since I am interested in bilingual memory representation as it may occur in speakers with varying degrees of proficiency in each language and in the effects of linguistic similarities/differences between two languages, I conducted a study on memory representation with unbalanced Korean-English bilinguals to test the bilingual dual coding hypothesis. This study is a replication of Paivio & Lambert (1981), but I have changed two factors: unbalanced bilinguals instead of balanced bilinguals, and Korean-English bilinguals instead of French-English bilinguals. Thus, my intention in this study was two-fold. First, I was interested in examining memory representation in *unbalanced* bilinguals. Second, I wanted to look at the effects of *linguistic similarities/differences* on bilingual memory recall.

An incidental free recall task was used to compare the effects of different coding conditions (Picture-Naming, Translation, and Copying conditions) on memory processing.

It was the same task that Paivio & Lambert (1981) had used in their study. They tested balanced French-English bilinguals and required their subjects to code a mixed list of pictures, French words, and English words into English by writing down the name of each picture, translating each French word into English, and copying each English word; then they unexpectedly asked subjects to recall the words the subjects had written down. They found that the mean recall percentages were highest for picture labels, next for translations, and lowest for copied words. Paivio and Lambert supported the dual coding theory in bilingual memory processing based on their findings.

This study tested a further application of a dual coding hypothesis for different bilingual subjects. The assumption was that the recall pattern might be different from that of Paivio & Lambert (1981), if subjects are unbalanced bilinguals. Thus, in this study, *unbalanced Korean-English* bilinguals were required to code a mixed list of pictures, Korean words, and English words into their weaker language - English - by writing down the name of each picture, translating each Korean word into English, and copying each English word. Then subjects were unexpectedly asked to recall the words they had written down. The mean recall percentages between the different coding conditions were compared. Moreover, the results from this study were compared with those of the Paivio & Lambert (1981).

Method

Subjects

Eighteen graduate students or spouses, nine of each sex, who were classified as Korean-dominant unbalanced bilinguals participated in the study. Mean age was 29.7 (sd = 2.99) and the years of residence in the U.S. was 5.4 years (sd = 3.9). All subjects spoke Korean as their first language. Every subject had begun to learn English in Middle School and came to the United States either to do their graduate work or to accompany their student spouse. All had native-like proficiency in Korean, but their degree of proficiency in English varied. English proficiency was (approximately) measured by a language background questionnaire using a self-judgment method. The mean score of the self-rated English proficiency was 3.4 (sd = 0.89) on a five-point scale, indicating ability to use English, but lack of proficiency in the language.

Materials

The stimulus items consisted of 60 words which were frequently-used common nouns and which could easily be depicted in pictures. These were initially selected based on the degree of concreteness and imagery with a rating of 6 or higher on a seven-point scale from a normative word list prepared by Paivio, Yuille & Madigan (1968). I omitted a few items and added some other items in order to fit the case of Korean-English bilinguals which was shown to be necessary in pilot testing. The words were also chosen to be distinctly Korean or English so that the borrowed words from either language (e.g., *ice cream* in English vs. [aiskriim] in Korean) were omitted.

Since 60 items were divided into three different stimulus modes (pictures, Korean words, and English words), three sets of lists were prepared with the same 60 words in order to give the 60 words an equal opportunity to be presented in each of the three modes. Items were randomly assigned to three different categories so that 20 items each serve as pictures, Korean words, or English words. These are then randomly arranged into a 60-item list. Two other lists are generated by systematically changing the mode of each item. Pictures become Korean words in the second list and English words in the third. Thus, every item has an equal chance to be presented in all three presenting modes (pictures, Korean words, and English words). Pictures were copied from many files of "Clip Arts" which were obtainable from the Macintosh computer software, Mac Paint 2.0. All pictures were drawn in black and white lines, and both English and Korean words were written by a computer, using the same font, in order to avoid a special impression for any items.

Procedure

Eighteen subjects were randomly assigned to one of the three lists. Since there were nine male subjects and nine female subjects, I first stratified the 18 subjects by gender and randomly assigned three of each sex to one of the three lists. Between males and females, and among three different list groups, there were no significant difference in the mean age, mean years of residence in the U.S., and the mean self-rating score of English proficiency. Thus my subjects were well distributed in each group. Subjects were tested individually in an incidental memory situation in which they were not told that later they would be asked to recall the items. The total amount of time for this test was about 20 minutes.

Task 1 (Coding Task). Subjects first listened to the following instruction in Korean.

> You are going to participate in an experiment that involves word and picture naming. I will show you 60 cards one by one. Each card contains either a picture, or a Korean word, or an English word. If you see a picture, write down the name of the object on your sheet in English, if you see a Korean word, write down its English translation, and if you see an English word, please just copy it down on your answer sheet.

Then, they practiced the procedure with three exemplary items. The cards were shown at five second intervals including an exposure duration. Subjects wrote their responses on the answer sheet. Task 1 took about five minutes to complete.

Task 2 (Recall Task). Subjects were asked to recall as many items as possible among the words that they had written down in English during the Coding Task (Task 1). They were allowed to recall the words for five minutes. They were then asked whether they had expected to recall the items before they did the Task 2.

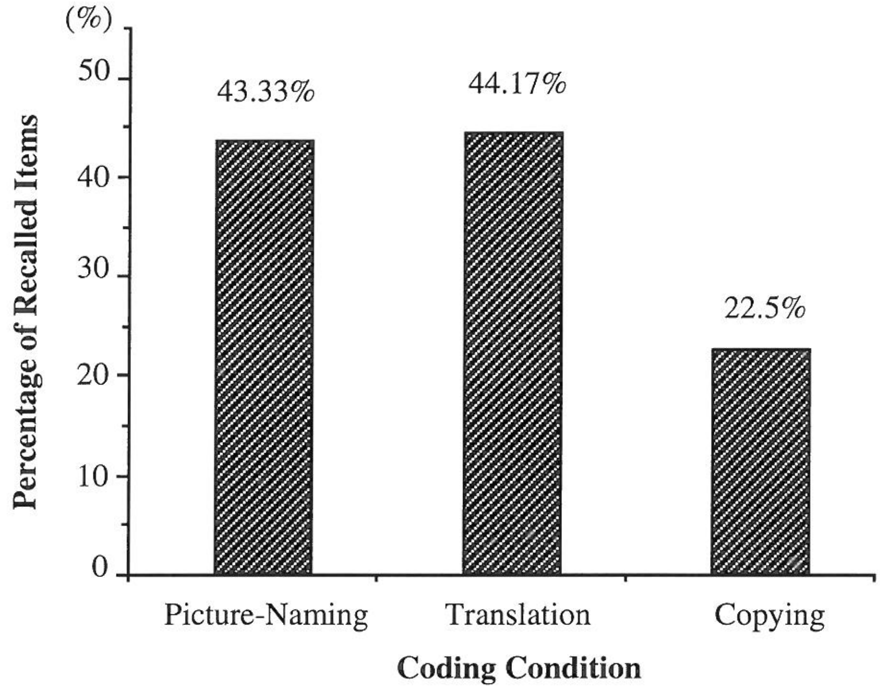
Task 3 (Recognition of presenting mode). After the Recall Task, the subjects were asked to indicate the stimulus category presented in Task 1 ("p" for pictures, "K" for Korean words, "E" for English words) beside the English version of each item, which was shown, this time, in alphabetic order. Subjects were given 5 minutes to indicate the presenting mode of each item.

Analysis and Results

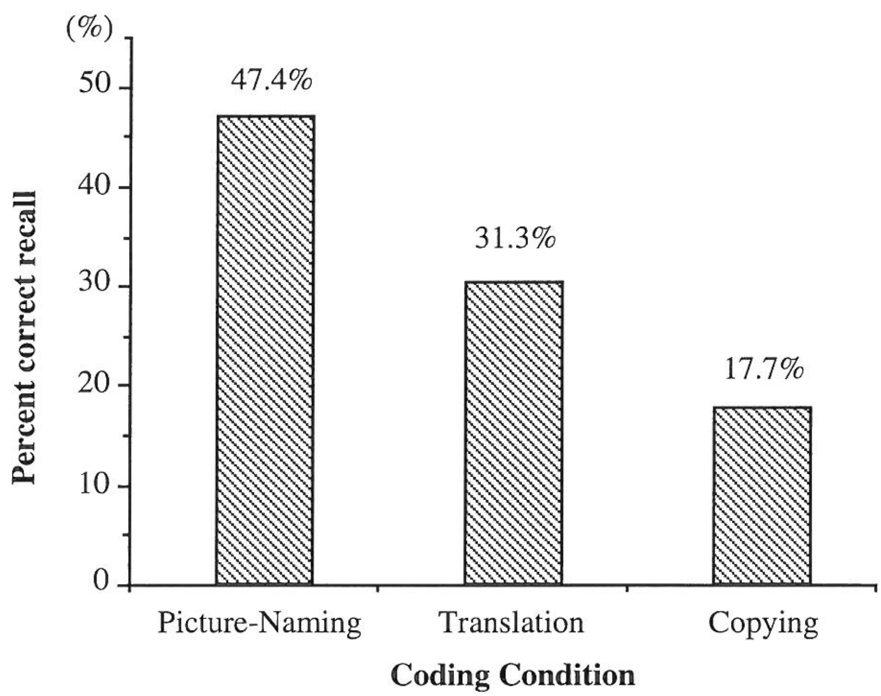
Analysis of Task 2

Mean number of total recalled items was 22, which was 36.67 % of 60 possible items. For each subject, numbers of recalled items were also counted for each coding condition: Picture-Naming, Translation, and Copying conditions. Percentage of recalled items was calculated on the basis of the number of correct responses divided by the total number of possible words (20 items) for each coding condition. According to the result of ANOVA test, mean percentage of recalled items in the three coding conditions (43.33% in Picture-Naming, 44.17% in Translation, and 22.5% in Copying conditions) was significantly different, $F\,(2, 34) = 18.11$, $MS_e = 149.76$, $p < .0001$ (see Figure 3-1).

[Figure 3-1] **Mean Percentage of Recalled Items in Task 2 by Coding Condition**



[Figure 3-2] **Mean Percentage of Recalled Items in Paivio & Lambert (1981)** *



* This figure was copied from Paivio & Lambert (1981), and re-drawn for this dissertation.

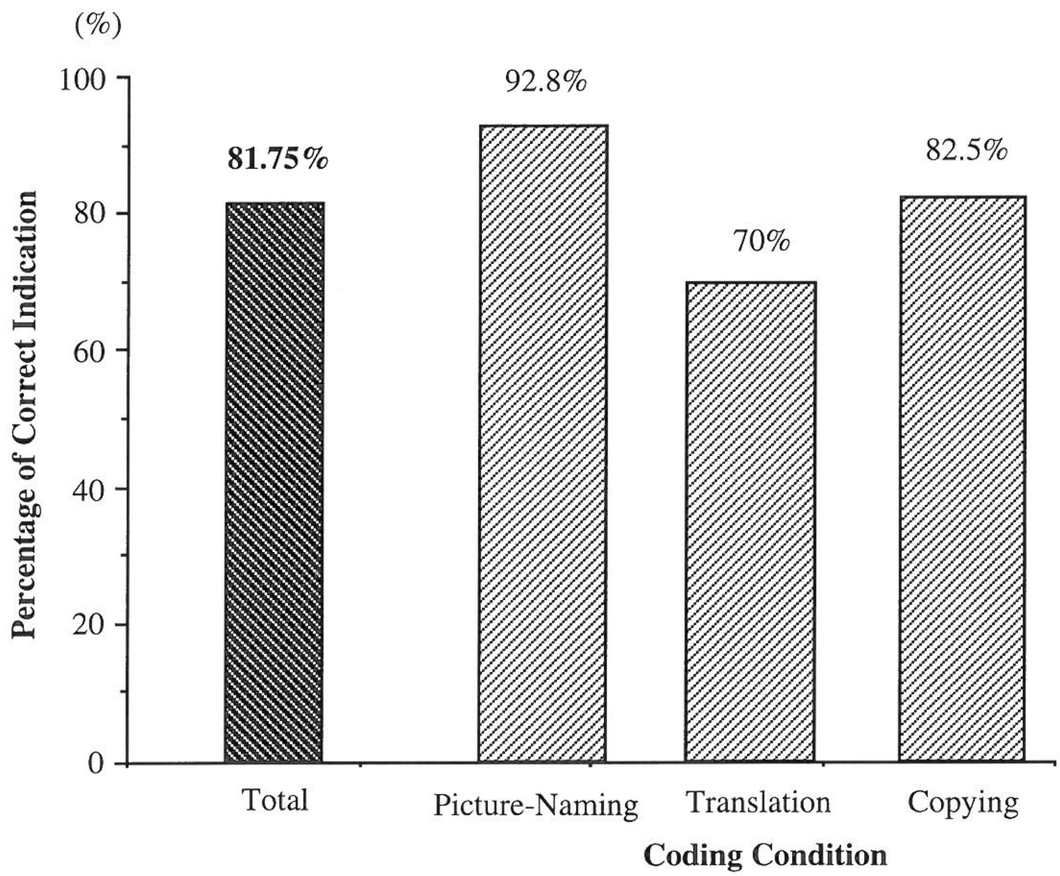
The approximate ratio of the three mean percentages of recalled items was 2 : 2 : 1, which is different from the findings reported by Paivio & Lambert (1981) with balanced bilinguals where the ratio was 3 : 2 : 1 (see Figure 3-2). Tukey's studentized multiple comparison showed that there was a significant difference in the mean percentages of recalled items between the Copying and the other two conditions, F (1, 17) = 53.93, MS_e = 72.43, $p < .0001$. There was no significant difference in the mean percentage of recalled items according to the subject's gender, age, the length of residence in the U.S., self-reported English proficiency level, or the stimulus item list.

Analysis of Task 3

During Task 3, subjects were asked to indicate the stimulus mode presented in Task 1 for each item: "P" for items which were presented in picture, "K" for items presented in Korean words, and "E" for items presented in English. Mean percentage of correct indication of the stimulus mode presented for each item was analyzed. Subjects correctly indicated the presenting mode for about 49 items (82%) out of the total 60 items. Among 20 items in each presenting mode, mean number of correct indication of the stimulus mode for each item was 18.56 (92.8%) for picture mode, 14 (70%) for translation mode, and 16.5 (82.5%) for copying mode. The results of ANOVA test showed that this finding was significantly different, F (2, 34) = 8.80, MS_e = 10.65, and $p < .001$ (see Figure 3-3). Comparisons by Tukey's studentized range (HSD) test showed that there was a significant difference between the translation mode and the other two modes, $p < .05$.

The errors that the subjects made when they tried to indicate the stimulus presenting mode for each item were also analyzed. Among the total errors made, 55 % occurred for items which required subjects to translate the stimulus items from Korean to English. 39 % were indicated as pictures and 16 % were indicated as English. 56 % of the total errors occurred in the case of picture indication for items presented in either Korean (38.72%) or English (17.36%) modes. The proportion of errors in presenting mode indication is presented in Figure 3-4. The result showed that subjects used imagery when items were presented with verbal stimuli. Specifically, bilingual subjects used imagery when they translated verbal stimuli into their other language. This aspect can be explained by the *referential connection* between imagery and verbal systems according to the assumptions made by the dual coding model and which was depicted earlier in Figure 2-4.

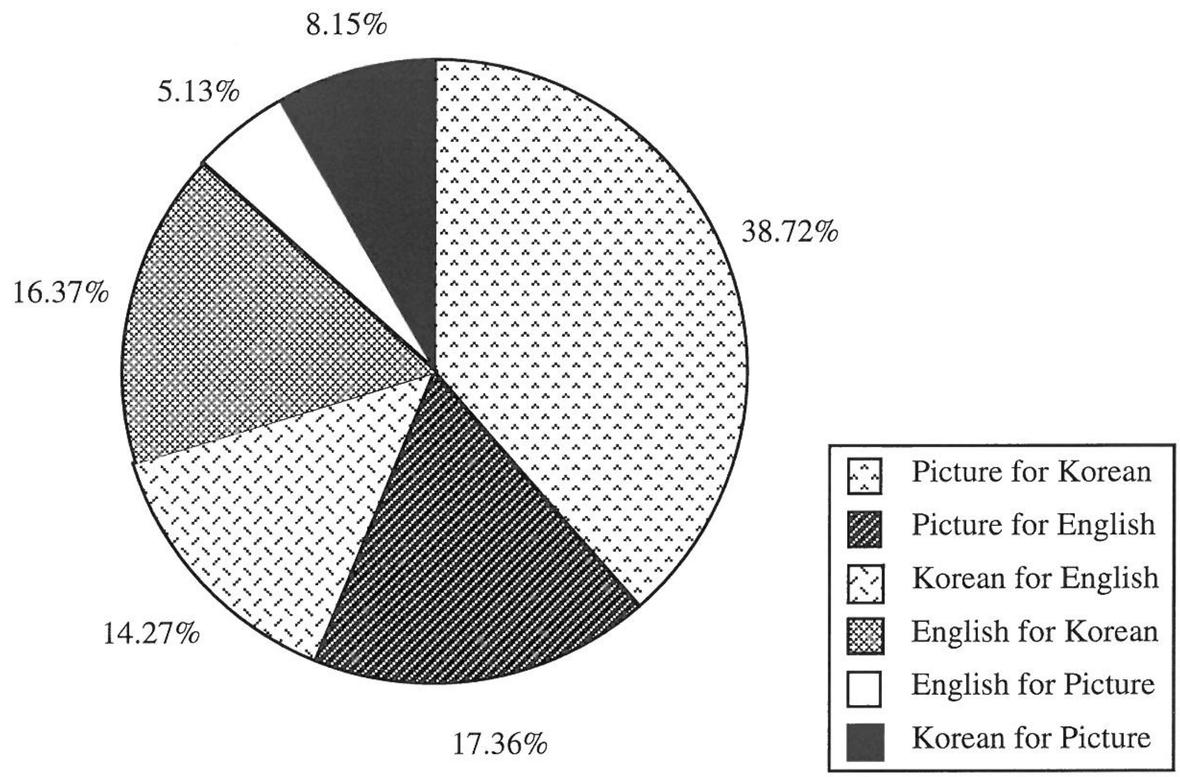
[Figure 3-3] Mean Percentage of Correct Indication of the Stimulus Mode Presented for Each Item in Task 3



Discussion: Findings and Suggestions

Subjects in this study recalled the items in the Picture-Naming or Translation condition significantly better than those in the Copying condition. This finding supports the bilingual dual coding hypothesis (Paivio, 1990; Paivio & Desrochers, 1980), which claims that verbal-nonverbal or bilingual coding has an additive effect on recall. However, the recall pattern found in this study is somewhat different from that of previous studies (Paivio & Lambert, 1981; Arnedt & Gentile, 1986). In the present study, the approximate ratio of recalled items according to the stimulus condition was 2 : 2 : 1 (Picture-Naming

[Figure 3-4] Proportion of Errors in Mode Indication in Task 3



condition : Translation condition : Copying condition) as can be seen in Figure 3-1. Items in the Translation condition were recalled almost the same as or more than those in the Picture-Naming condition and items in the Copying condition were recalled the least. This result contrasts with the findings in the study of Paivio & Lambert (1981) in which the recall ratio was 3 : 2 : 1 (see Figure 3-2).

Unbalanced bilingual subjects in this study recalled the items in the Translation condition much better than did balanced bilinguals in Paivio & Lambert (1981). A high recall rate for translated items has also been reported by Arnedt & Gentile (1986) for bilingual subjects who learned their second language in a traditional classroom environment. However, the Arnedt & Gentile (1986) findings are still within the same range of the 3 : 2 : 1 recall ratio reported in Paivio & Lambert (1981) study. For example, Arnedt & Gentile (1986) reported that their recall ratio was 3.1 : 2.4 : 1 for subjects who

were in the core language program which relied on translating skills to learn the language, whereas the recall ratio was 3.9 : 2.4 : 1 for subjects who were in immersion programs.

In contrast, the current study with unbalanced Korean-English bilinguals who learned English as a foreign language in a classroom environment produced a much higher recall rate for items in the Translation condition than Paivio & Lambert (1981) and Arnedt & Gentile (1986). The 2 : 2 : 1 recall ratio for items in the Picture-Naming, Translation, and Copying conditions in the present study can be explained in two different ways. First, items in the Translation condition were recalled in the same proportion as those in the Picture-Naming condition. Thus the additive effect on recall was similar for Translation and Picture-Naming. Second, items in the Copying condition were recalled relatively more in this study than in the previous studies. Compared to the number of recalled items in the Picture-Naming condition, half as many items were recalled in the Copying condition in the current study. This compares to only one third or even one fourth of the number of recalled items in previous studies. This means that unbalanced bilingual subjects in the current study recalled the items in the Copying condition much better than balanced bilinguals did in earlier studies. What can be noted in the current study is that subjects wrote the answers in the coding task in English which was their weaker language. I assume that using a weaker language in the coding task enhanced the recall even when subjects just copied the items.

Thus, the findings from this study show that a bilingual's memory representation is affected by both degree of bilinguality and manner of second language acquisition as well as which language bilinguals use in the coding task. A two-fold explanation is offered to account for the findings of the present study: first, unbalanced Korean-English bilinguals who had learned English without much exposure to the language in natural contexts relied heavily on translation between Korean and English when they recalled; and second, they recalled items in the copying mode relatively better than balanced bilinguals when they coded the items in their weaker language. However, I changed two factors from the original design of the study done by Paivio & Lambert (1981): from balanced to unbalanced bilinguals, and from French-English to Korean-English bilinguals. Moreover, since the subjects in the present study were Korean-dominant unbalanced bilinguals, the coding language which was English was their weaker language. Therefore, I cannot pinpoint which factor contributes most to the difference in findings between this study and earlier studies. It might be because of a difference in orthography between the two languages: both English and French use almost the same alphabets while Korean has a very different orthography. Thus, my subjects might have benefited from a salience effect due

to the differences in orthographies resulting in recalling more translated words than those of French-English bilinguals. On the other hand, the findings may be due to the subject's being unbalanced in two languages. Since the subjects of this study were not as proficient in English as in Korean, this may have contributed to the greater recall of translated items.

We can ask ourselves why the unbalanced Korean-English bilinguals in this study recalled the translated items as much as the items in the Picture-Naming condition unlike the balanced French/English bilinguals in earlier studies. Further, we can ask why the items in the Copying condition had been recalled relatively more in the present study than in the previous studies. In order to try to answer these questions, another study needs to be conducted in which all three factors (degree of proficiency level in the two languages of the bilingual, linguistic similarities and differences between the two languages of the bilingual, and the coding language difference between the subject's dominant and weaker language in the coding task) will be manipulated to examine the effect of each of these factors on memory recall in bilinguals.

Thus, in the follow-up study, *degree of bilinguality*, *linguistic relationship* between the two languages of the bilingual, and *coding language* will all be examined to determine their effects on memory recall. This study is reported as in Chapter 5 of this dissertation.

CHAPTER 4

STUDY II: SELECTION OF STIMULUS ITEMS FOR BILINGUAL MEMORY RESEARCH

Investigators studying aspects of verbal processes have had access to extensive normative data on various objective and subjective dimensions of their verbal materials. For example, Brown (1976) compiled a catalog of scaled verbal materials that included 172 studies providing such information. On the other hand, concerning the normative data on characteristics of pictorial representations of concrete nouns, Snodgrass and Vanderwart (1980) presented a standardized set of 260 pictures based on four variables of central relevance to memory and cognitive processing: name agreement, image agreement, familiarity, and visual complexity. This standardized set of pictures with their agreed name can be used in experiments in both semantic and episodic memory tasks, where memory processing in both verbal and pictorial modes is examined. However, this set of pictures and related verbal materials (Snodgrass and Vanderwart, 1980) used in memory research may not be appropriate, if it is used in research on *bilingual* memory processing, because the normative data of nouns and pictures have been obtained from ratings of monolingual English-speaking subjects.

Words may evoke different images and have varying degrees of familiarity in different languages because each language is embedded within its own cultural context (which may differ from one culture to another). Of course, even in the same language a word can evoke varying images in different individuals depending on the manner and context in which the person learned the word. Similarly, a word can vary along a continuum of familiarity depending upon the person's experience with the word. An assumption made here is that in the imagery and familiarity that we attach to certain words, there will be more variability across languages than within a particular language.

In many experiments on bilingual memory, "translation equivalents" of words have been used without any consideration of whether the translations are truly equivalent items. Translation equivalents may not necessarily activate the same image although there may be

a degree of overlap between the images evoked by two different languages. Arnedt & Gentile (1986) suggested that the translation mode in memory recall of bilinguals was influenced by language acquisition history. Moreover, Winograd, Cohen & Baressi (1976) postulated the existence of *cultural imagery*, which implied that bilinguals would have slightly different images associated with translation equivalents. This suggests that there is no one-to-one correspondence in translation equivalents across languages, but rather a certain degree of overlap.

Since the main study (Study III) of this dissertation involved memory processing in Korean-English and Spanish-English bilinguals, my first task was to determine whether the list of words list were free of cultural boundedness or whether they were too language-specific. Therefore, I had to carefully select stimulus items (i.e., words) that had high imagery and familiarity in all three languages (English, Spanish, and Korean) in order to minimize extraneous variability that could have arisen because of language-specific items.

Since I planned, in Study III, to use picture stimuli of nouns, I had to take special care also in selecting my pictures. Research showed that abstract nouns have less common images among people than concrete nouns (Koler, 1963). Also, concrete nouns are much more easily drawn as a picture. Thus, it was recommended that concrete nouns be used in this kind of memory research. However, the same picture of a concrete noun may evoke different names because either the picture does not clearly represent the intended item or respondents may have a different point of view when examining the picture. Therefore, it is important to select pictures that clearly represent the intended word so that the majority of respondents agree on one common word across the three languages. Sometimes, a certain picture may have two or more synonyms that are commonly used in response to the picture. If a picture evokes two or more synonyms, a memory recognition task could be influenced by the way in which subjects name the item. Thus, pictures that have only one dominant name are preferable in research that involves memory recognition.

In Snodgrass & Vanderwart (1980), subjects were asked to name each picture and then the data were examined to see how many subjects agreed with the dominant name on each picture to determine picture-name agreement. These investigators also asked subjects to rate image agreement and visual complexity of each picture to see the clarity of the picture. In order to select picture stimuli for Study III, I needed to ensure that each picture represented the intended word in all three languages. In addition, I ensured that each picture evoked a common name and that there was only one common name for the picture in each of the three languages (English, Spanish, and Korean).

In order to satisfy all the criteria discussed above (high imagery, high familiarity, a single common name for a picture, and picture clarity), I conducted this study that had as its purpose the preparation of a set of pictures and their names, from which I could then select appropriate stimulus items for cross-language (bilingual) memory experiments.

Method

Subjects

Sixty adult subjects were involved in this study: 20 subjects for each of the following languages (English, Spanish and Korean) who were dominant in one of the languages. Information on subjects is summarized in Table 4-1. The mean age of subjects was 31.67. Most of them were college graduates or more (28 college graduates; 26 Masters or Ph.D. holders; and 5 high school graduates). The nationalities of the subjects in each language group generally conformed to the following pattern: the United States for

[Table 4-1] Information on Subjects involved in Stimuli Selection Study

	English group	**Spanish group**	**Korean group**
Mean Age	33.65 (+/- 9.9)	31.60 (+/- 5.6)	29.75 (+/- 3.1)
Nationality	20 U.S.A.	11 Mexico 7 Cent. & South America	20 Korea
First Language	19 English 1 no response	19 Spanish 1 Spanish & English	20 Korean
Dominant Language	20 English	20 Spanish	20 Korean
Education	2 high school 11 college 7 graduate school	3 high school 8 college 8 graduate school 1 no response	9 college 11 graduate school

English; Mexico for Spanish; and Korea for the Korean group. Therefore, the first languages of the subjects were mostly English, Spanish, or Korean and their dominant language remained the same as their first language at the time of this survey.

Materials

180 pictures and their one-word noun name were used in this study. To arrive at a list of these words and pictures that could serve as a basis for this study, several criteria were established for the selection of words. The criteria for the word selection were as follows:

- Common words in all three languages: Words should have high frequency in the three languages and all speakers of the language should know the words in their language.

- Concrete nouns: not abstract nouns. (e.g., pencil vs. peace)

- Picturable words: high imagery (a mental image) words which can also be depicted as an *unambiguous* picture.

In selecting words, I first checked some of the word frequency tables (e.g., Eaton, H.S., 1961; Francis, W.N., 1982; Hall, Nagy & Linn, 1984; Johansson, S., 1978; 1989; Thorndike & Lorge, 1952; and Zettersten, A., 1978). However, I found that the weakness of the word frequency books was that the frequency tables only represented a certain aspect of verbal behavior. For example, the frequency table for press reportage is only a reflection of word usage in press (e.g., Zettersten, A., 1978) and the frequency table for science is only a reflection of scientific word usage (e.g., Johansson, S., 1978). Another weakness of the frequency tables examined was that although a frequency table may have been produced based on the *number of uses* of each word in a certain area, the common and easy words were not always the words frequently *used* in everyday speech or in certain areas of writing. For example, the word *monkey* is a very easy and common word but since the word *monkey* is not frequently used in everyday speech, it may have a low frequency on the frequency table. Therefore, it became apparent that I could not get the most appropriate word list from only a single specific reference and decided to refer to several additional resources to select material for my list of words. The followings are references that I consulted to prepare the list of this study.

1. I used the frequency table from Thorndike & Lorge (1952) and included only concrete words that were in categories AA (over 100 uses per million words) and A (over 50 uses per million words).

2. From a list prepared by Paivio et al. (1968), I selected words if the word was rated over 6 on a 7-point scale in all three categories (concreteness, imagery, and meaningfulness) and added them in the list of this study. However, I excluded any words for which it was apparent that an unambiguous picture was not possible (e.g., a picture for *boy* could be confused with that of *child*).

3. I referred to the word list prepared by Durgunoglu and Roediger (1987) in their bilingual study and added words which were not selected by the above two procedures.

4. I examined the way that Snodgrass and Vanderwart (1980) chose their list of pictures. I also reviewed the pictures available from the Clip Arts on the Macintosh computer. Pictures were taken from either the Clip Arts or copied from pictures available in the report prepared by Snodgrass and Vanderwart (1980) depending on the picture clarity judgment done by a pilot testing.

This process resulted in 229 potential words. However, when pictures were sought for the words, the final list was reduced to 180 words. Selected words in three languages (English, Spanish, and Korean) and pictures for this study are shown in Appendix 1.

Procedure

Subjects were asked to rate a list of words and pictures. In this rating study, four different tasks (Imagery task, Familiarity task, Picture Naming and Picture Clarity rating task) were used . A list of 180 words were given alphabetically in the Imagery and Familiarity tasks, and they were randomized for the Picture Naming and Picture Clarity rating task. The order of these four tasks was randomized to decrease an influence from one task to another.

In the Imagery task, subjects were asked to rate each word on a 7-point scale as to the ease or difficulty with which the word aroused a mental image. In the Familiarity task, subjects were asked to rate each word again on a 7-point scale according to the degree of

familiarity of the word to the subject. In the Picture Naming and Clarity tasks, subjects were first asked to write a name of each picture, the first name that came to their mind. If the picture was of an object unknown to them, they were asked to respond DKO (don't know object); if the object was known but the name was unknown, DKN (don't know name); and if subjects knew the name, but it was momentarily irretrievable, TOT (tip of the tongue). After naming the picture, they were asked to rate the degree of representativeness of the picture for the name on a 5-point scale. This meant that subjects had to rate each picture according to how clearly and unambiguously the picture represented the object that they had named.

Results and Item Selection

I will first describe the results of the rating data in each task by each language. Descriptive statistics of ratings in each task by each language will be given and the relationships between tasks in each language and the relationships between languages on each task will then be examined. After a general description of the data and an examination of overall relationships, I will describe the criteria that I developed to enable me to select a common set of stimulus words across the three languages.

Descriptive Results of the Study

Description of the rating data. Means and standard deviations (SD) for ratings in each language for each task are given in Table 4-2. The mean ratings on the three languages in each task are also given in Table 4-2. In Figure 4-1, we can see the box plot[3] distributions of ratings in each language by each task as well as the distribution of the mean ratings on the three languages in each task. We can see that all the data are skewed to the right, which means that most of the items were rated very high. The high ratings were not unexpected because I originally selected the items based on the high imagery and familiarity ratings reported in other studies. A measure of skewness for each distribution is also presented in Table 4-2. If the measure of skewness is between - 1 and + 1 this means that

[3] For a discussion of the box plot technique as an effective visual representation of a data distribution, see D.S. Moore & G.P. McCabe (1989). Introduction to the Practice of Statistics, W. H. Freeman and Company, pp. 35 - 37.

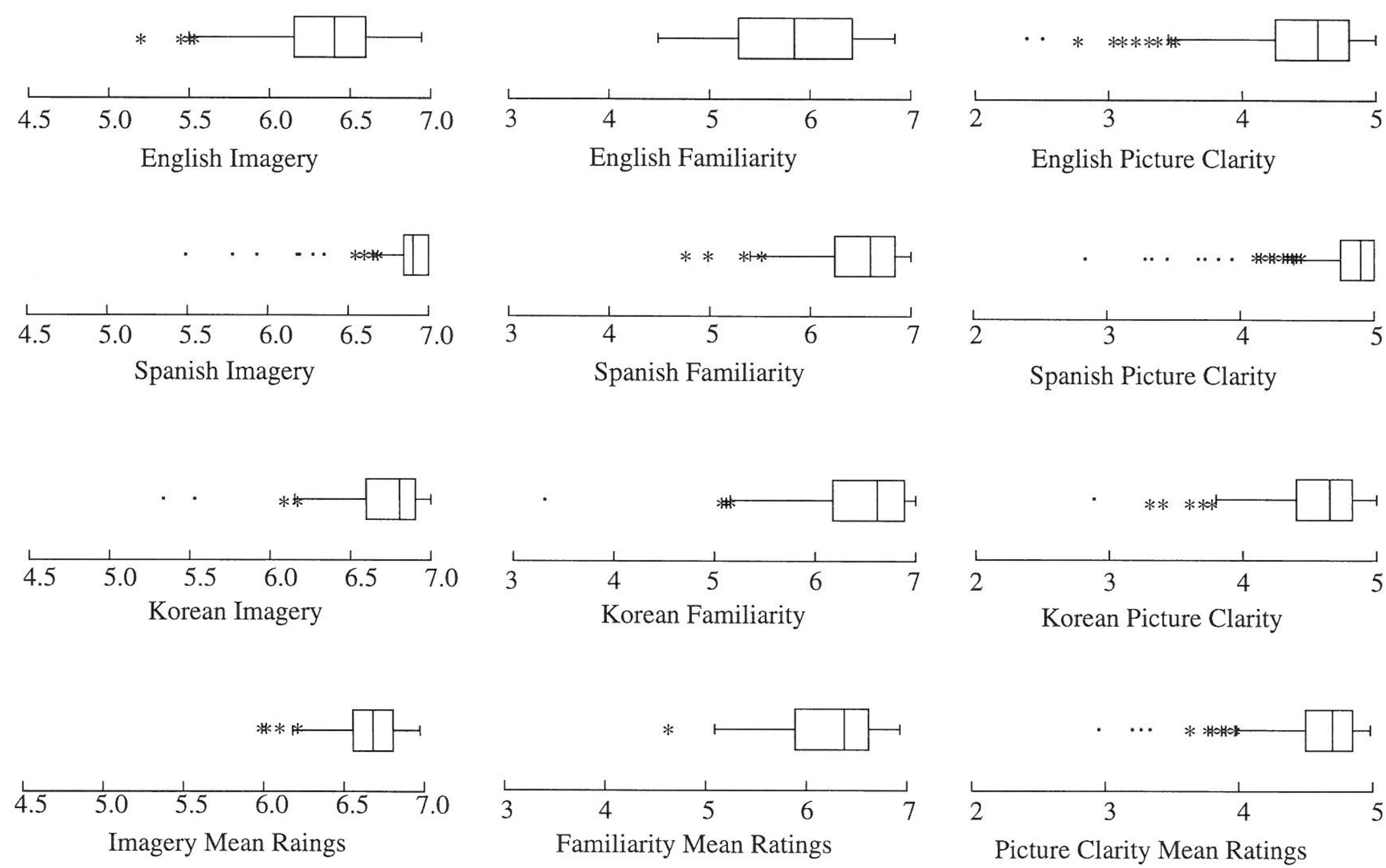
[Table 4-2] Descriptive Statistics of Ratings for 180 Items in Each Task by Each Language

Task	Language	Mean	SD	Skewness
Imagery	English	6.334	0.361	- 0.879
	Spanish	6.847	0.228	- 2.939
	Korean	6.729	0.253	- 1.927
	mean	**6.637**	**0.211**	**- 1.030**
Familiarity	English	5.815	0.621	- 0.155
	Spanish	6.490	0.449	- 1.193
	Korean	6.468	0.541	- 1.788
	mean	**6.258**	**0.477**	**- 0.644**
Picture Clarity	English	4.418	0.527	- 1.500
	Spanish	4.761	0.379	- 2.429
	Korean	4.562	0.356	- 1.580
	mean	**4.580**	**0.382**	**- 1.724**

the distribution is normal. An examination of Table 4-2 reveals that a normal distribution was only apparent for the English Imagery and English Familiarity tasks and the remaining seven distributions all were skewed in the direction of high scores.

Relationships between ratings. In order to examine the various relationships within and between languages both within each task and across three tasks, Pearson product correlations were calculated. Table 4-3 presents a correlation matrix for ratings on the three tasks by each language. The table 4-3 provides all within and between language correlations on the tasks. Visual displays are also given in Figures in Appendix 2. Figures A2-1, A2-2, and A2-3 show the relationships between different languages for each task while Figures A2-4, A2-5, and A2-6 depict the relationships between different tasks within a language. The significance level of each relationship was given on each plot. We can see that most of the correlations are highly significant.

[Figure 4-1] Distributions of Ratings Based on a Box Plot Techique for Each Task by the Three Language



[Table 4-3] Pearson Product Correlation Matrix between All Ratings

- For information on abbreviations: Eng: English; Spa: Spanish; Kor: Korean; I: Imagery; F: Familiarity; P: Picture Clarity.
- Bold-faced number means that the significance level is less than 0.01.
- Italicized number means between-language correlation, and underlined number means between-task correlation.

		Imagery			Familiarity			Picture Clarity		
		Eng	Spa	Kor	Eng	Spa	Kor	Eng	Spa	Kor
I	Eng	1.000								
	Spa	***0.255***	1.000							
	Kor	***0.420***	***0.322***	1.000						
F	Eng	0.158	**0.331**	**0.339**	1.000					
	Spa	0.023	**0.610**	0.245	***0.754***	1.000				
	Kor	0.068	**0.377**	**0.620**	***0.670***	***0.610***	1.000			
P	Eng	**0.522**	0.163	**0.482**	0.095	0.002	0.079	1.000		
	Spa	**0.378**	0.197	**0.446**	0.215	0.123	0.137	***0.765***	1.000	
	Kor	**0.270**	0.250	**0.512**	0.193	0.141	**0.295**	***0.695***	***0.740***	1.000

In the Imagery task, the correlations between the different languages were low (see Table 4-3 and Figure A2-1 in Appendix 2: between English and Spanish, $r = 0.255$; between English and Korean, $r = 0.420$; and between Spanish and Korean, $r = 0.322$); however, all the correlations were significant, $p < 0.001$. In contrast, the Familiarity and Picture Clarity tasks resulted in correlations between different languages which were very high (see Table 4-3 and Figures A2-2 and A2-3 in Appendix 2). For the Familiarity task, the correlations were: $r = 0.754$ between English and Spanish; $r = 0.670$ between English and Korean; and $r = 0.610$ between Spanish and Korean. For the Picture Clarity task, the correlations were: $r = 0.765$ between English and Spanish; $r = 0.695$ between English and Korean; and $r = 0.740$ between Spanish and Korean. All the correlations in the Familiarity and Picture Clarity tasks were highly significant, $p < 0.0001$. These results confirmed that

subjects agreed on the degree of word familiarity and picture clarity even though the respondents represent different language backgrounds.

Relationships between different tasks in each language group were also moderately high except in the cases involving the correlation between the Familiarity and Picture Clarity tasks in English ($r = 0.095$; $p < 0.25$), and in Spanish ($r = 0.123$; $p < 0.5$). Although the correlations between different tasks were significant overall (as shown in Table 4-3 and Figures A2-4, A2-5, and A2-6 in Appendix 2), it was evident that the between-task correlations in each language group were lower than those of the between-language correlations in each task.

In sum, correlational analyses between the various tasks and languages showed that ratings in the three languages were strikingly similar within a task category. On the other hand, ratings across different tasks within a language were not as highly correlated. Although many correlations resulted in significant p values across different tasks, these findings may be attributable to the large number of items ($n = 180$) that were rated on each task.

Criteria for Selecting Items for Research in Bilingual Memory

Since every item was rated on three separate tasks in all three language groups, it was necessary to establish criteria for selecting appropriate items for use in the bilingual memory research contemplated. Appropriate items should be words that evoke high imagery in all three languages, and that are highly familiar to the speakers of all three language groups. For purposes here a high imagery item is a concrete noun that readily lends itself to a single mental image. If a word evokes two or more very different images such as *nails*, (which could evoke either an image of fingernails or that of nails as an object for hammering), then these words are excluded because they would add unwanted variance in a memory recognition task.

Words of necessity must be equally familiar to the speakers of all three language groups again to eliminate any undue influence because of differences in word familiarity across languages. For example, *dragonfly* was a very familiar word to the Korean-speakers, but not as familiar to the English- or Spanish-speaking respondents. Another situation that occurred in the selection of stimulus words was when a word was borrowed from one language and used in another, or when the identically-spelled or like-sounding words were used in two (or all three) languages. In these cases the words were also

excluded because of their potential for adding extraneous variation to a recall or recognition memory task.

Concerning the pictures, the pictorial expression of each item must be clearly and unambiguously drawn since my research also requires a picture of each item. In addition, each picture should evoke one common name from subjects. If two or more names are often given in response to any picture then that pictorial representation must be excluded from the selection of items because pictures with more than a single name could add another source of unwanted extraneous variation to a recognition task in memory research.

I first established a rule that items (words or pictures) would be selected if their rating exceeded the average in each task. For example, in regard to the Picture Clarity task in Korean, the average rating was 4.562. Therefore, any items that were rated above this average were first selected. Since this process generated a matrix with 9 cells (3 tasks $\times$ 3 languages), items were identified as belonging or not belonging to each task by language combination cell on 9 separate occasions. These selections are marked by means of shading in Appendix 3. On the basis of a total pool of 180 items, Table 4-4 presents the number of items that met this selection rule for each task by language combination. Table 4-4 also shows the number of items that were chosen by this rule using the mean scores on the ratings of the three languages for each task. The selected items based on the mean scores on the ratings of the three languages are also marked by means of shading in Appendix 3.

[Table 4-4] Number of Selected Items in Each Task by Each Language Group

Task \ Language	English	Spanish	Korean	**Mean Scores***
Imagery	110	135	104	**107**
Familiarity	92	114	111	**107**
Picture Clarity	115	129	104	**124**

(* This column represents the number of selected items for each task based on the mean scores on the ratings of the three languages.)

Once a manageable pool of items was identified (see Table 4-4 and Appendix 3), six additional criteria were established for the selection of usable items (words and pictures). The criteria are as follows:

Criterion 1: High clarity of the picture. I established *clarity of pictures* as a first criterion to choose items because it is essential that the pictorial representation of a word be clear and unambiguous within and between every language group. Thus, I first sorted the whole rating data based on a decreasing order of Picture Clarity ratings, using a mean score based on the ratings of the three languages (see Appendix 3). I selected the item if its mean score on the three languages in the Picture Clarity task was above the average score of 4.58. On the basis of this first criterion, 124 items were selected.

After selecting stimuli using Criterion 1, some items were not selected in one or two of the three language groups although they were chosen based on the mean score of ratings in the three languages. I checked each of these items to see whether there was a big difference among the ratings in the three different language groups. I found that the rating of those items was still within one standard deviation from the average rating in each language, except one item *leaf*. Korean language subjects rated a picture of a *leaf* much lower than the other two language groups. The rating of the picture of a *leaf* in the Korean group was 4.1, which was more than one standard deviation (0.356) below the average (4.562). This means that the specific picture of a *leaf* in this study was not very clear to the Korean-speaking respondents. Therefore, *leaf* was excluded and a total of 123 items was selected using the first criterion.

Criterion 2: High imagery and familiarity of the word. The second criterion was determined by high imagery and familiarity of the word in all three languages. Among the 123 items chosen by the first criterion, I selected the items whose mean score on the ratings of the three languages was above the average in both the Imagery and Familiarity tasks. On the basis of this second criterion, 60 items were excluded from the total 123 items and 63 items remained. I checked the variability of ratings in the three languages for these 63 items in the Imagery and Familiarity tasks. I found that some of these items were not selected in one or two of the three language groups. However, I decided to include all 63 items in this selection because although some of their ratings were below the average they were still within one standard deviation from the average in each language group.

Criterion 3: Unambiguous words both within and between languages. I also checked whether any of these 63 words selected by the first two criteria could be used with two or more different meanings in each language (i.e., homonyms). As I have already explained, words with different meanings could evoke different images in different individuals. Among the total pool of 180 words, six words were reported within this category. In English, *bat* is used as an animal or as a baseball bat; *bow* to decorate or in an arc; and *nail* for fingernails or as an object for hammering. In Korean, *noon* means both eyes and snow: although the pronunciation is different by the length of the vowel - with the short vowel, [nun] meaning eyes and with the long vowel, [nu:n] for snow - these words are written exactly the same in Korean. Also, *chong* in Korean means both a bell with a short vowel [chong] and a servant with a long vowel [cho:ng]. In Spanish, the word *reloj* is used for both a clock and a watch. Among these six words, all three English words were already excluded by criteria 1 and 2. I decided to exclude two words, *bell* and *eye*, because these two words are ambiguous in written form in Korean. I also decided to exclude the word *watch* because the Spanish word *reloj* means both watch and clock. However, I decided to keep the word *clock* in the list because *clock* is a more general term and there is no difficulty among Spanish speakers in interpreting *reloj* as a clock.

Moreover, I found an ambiguous word between languages. The English word *foot* can be ambiguous when it is translated into Spanish *pie*, which can mean a kind of pastry that we eat such as apple pie in English. In the prospective bilingual memory research, subjects in the Spanish-English bilingual group will see a mixed list of English words, Spanish words and pictures. Therefore, the Spanish word *pie* will be ambiguous when presented to Spanish-speaking subjects because there will be no indication whether this word is English or Spanish. As a result, I excluded this item, *foot*, from the possible list. Therefore, employing the third criterion resulted in the elimination of four more items (bell, eye, foot, and watch) from the pool of 63 items selected by the first two criteria. Thus a pool of 59 items remained.

Criterion 4: Neither borrowed words nor identically-spelled cognates between languages. As I explained earlier, borrowed words or identical cognates in two or more languages may influence memory recall or recognition. Thus, the fourth criterion excludes an item if its name is similar in two (or all three) languages. For example, Korean borrows the following English words: belt, boot, bus, cake, camera, coat, cup, fork, harp, helicopter, necktie, piano, truck, violin, and zipper. Even though Korean has a different orthography from that of English, these words are written based on their English

sound. If we look at these words written in Korean they look different from English words, but if we read them (even in sight-reading) the sound is very similar to that of English words. On the other hand, between English and Spanish, there are many cognates or borrowed words: such as angel/angel; camera/camara; piano/piano; violin/violín, zebra/cebra, etc. Criterion 4 resulted in the deletion of seven more words (bus, cake, camera, cup, fork, truck, and violin) from the 59 words that were selected by Criteria 1, 2 and 3. Thus at this stage a total of 52 items remained.

Criterion 5: One and only one name for the picture. The fifth criterion excludes an item if its pictorial representation evokes one or many synonyms or different names. (e.g., airplane/plane; bicycle/bike; boat/sailboat; gun/pistol; mouse/rat; necktie/tie; newspaper/paper; anteojos/gafas; buho/tecolote; paraguas/sombrilla; pescado/pez; sapo/rana; etc.). Appendix 4 lists the number of different name occurrences for each item in the three languages with specific names given by the respondents. Appendix 4 also shows the total number of different name occurrences in all three languages. I established a rule that words that had more than six occurrences of different names across the three languages should be excluded. Following this criterion, fourteen more items (airplane, ball, bicycle, car, chicken, corn, ear, fish, glasses, lips, moon, toothbrush, tree, and umbrella) were excluded from the 52 items that were selected by employing the above four criteria. This resulted in an item pool of 38 items at this point in the selection process.

Criterion 6: More animal (or bird, insect) names. I found that many animal (or bird, insect) names had been excluded by Criterion 2 because of their low familiarity ratings. Although many animal names are not mentioned very often in our everyday speech so that they do not seem highly familiar words, they are actually very common and easy words. Thus, I decided to reintroduce, in my item list, some of the easy and common animal names which had been excluded simply on the basis of their low familiarity ratings. The rule I used to select these words was as follow: If the mean familiarity score of a word on the ratings in the three language groups was below the average rating (M = 6.258) but within one standard deviation which is above the rating 5.781, such a word was selected unless the word's mean scores of the Imagery and Picture Clarity tasks were below the average (M = 6.637 for the Imagery task; and M = 4.580 for the Picture Clarity task).

Fourteen animal (or bird, or insect) names were chosen for inclusion (i.e., bear, camel, duck, eagle, elephant, giraffe, horse, lion, monkey, mouse, rabbit, snail, tiger, and turtle) by this method. I checked the variability of familiarity ratings of these 14 animal

names in each language group. Among these words, the familiarity rating of eight animal names (bear, duck, elephant, horse, monkey, mouse, rabbit, and tiger) was within one standard deviation below the average in each language group and that of other five animal names (camel, eagle, lion, snail, and turtle) was within two standard deviations from the average. One animal name, *giraffe*, was not chosen by this selection process because this word had gotten a familiarity rating (5.4) which was slightly lower than two standard deviations below the average (5.386) for the Spanish-speaking respondents. However, since this difference was so small and it happened in only one language group, I decided to include this item in my list of stimulus items. Therefore, this process added 14 more animal names to the list and it resulted then in a pool of 52 words.

Criterion 7: More meaningful items and replacement of some pictures. In order to arrive at a list of 60 items, eight more items were needed. I re-examined the items that had been excluded through the use of Criterion 2 because of their low imagery and/or low familiarity ratings, but not by other criteria. Upon reconsideration, I decided to check the items whose imagery and/or familiarity ratings were within two standard deviations below the average in each language group. Fourteen items were identified within this category (i.e., basket, bottle, bread, brush, church, cigarette, circle, envelop, glass, iron, stamp, table, triangle, and train). Among these 14 items, I selected seven items (basket, bottle, bread, cigarette, iron, table, and train) that had a clearer pictorial representation, fewer multiple names for the picture given by respondents, and which were more meaningful (e.g., *circle* and *triangle* were not very meaningful words and were excluded). I also decided to include an item, *tree*, in the prospective list after I found a much better picture of a tree later, since the item *tree* was excluded because of its ambiguous pictorial representation which produced in Spanish both *tree (arbol)* and *pine tree (pino)*.

Thus a list of 60 items - both words in the three languages and their pictorial representations - for the prospective bilingual memory research was finalized by the process of using the seven criteria described above. However, while I was analyzing the data, I found some better pictorial representations than those I had used in this item selection study for a few of the items. For example, the pictures of *dog* and *cat* that I had used in the study looked somewhat like a puppy and a kitten. As a result, six Korean respondents used *puppy* in reference to the picture of a *dog*, and five of the English-speaking subjects used *kitten* for the picture of a *cat*. Pictures that I found later were unambiguously named either *dog* or *cat* by native speakers of the three languages in a small group testing that I carried out. I also replaced the picture of a *giraffe* after I found a much

better pictorial representation. Therefore, I decided to replace the pictorial representation of these three items with my newly-found pictures.

Selected 60 stimulus items for the bilingual memory research. By employing the seven criteria described above, I was able to arrive at a final set of 60 stimulus items (in both words and pictures) for my bilingual memory research with Korean-English and Spanish-English bilinguals which is described in Chapter 5 (Study III). The 60 items in three languages (English, Spanish, and Korean) with their picture representations are shown in Appendix 5. The items are arranged according to the English-alphabetical order. These items have high imagery in all three languages and are very familiar to speakers of all three language groups. Moreover, they are the items whose picture clearly represents the intended word. Now that I have concluded my selection process and have identified 60 stimulus items (words and pictures), I am ready to proceed to the next stage of my memory research involving Korean-English and Spanish-English bilinguals.

CHAPTER 5

STUDY III: BILINGUAL MEMORY REPRESENTATION: FURTHER APPLICATION OF THE BILINGUAL DUAL CODING MODEL TO KOREAN-ENGLISH AND SPANISH-ENGLISH BILINGUALS WITH VARYING DEGREES OF BILINGUALITY

In order to better understand memory representation in bilinguals, a more elaborated research study was needed. In this chapter, bilingual memory representation was examined with particular attention to three major factors believed to be important in bilingual memory processing. These three factors are *degree of bilinguality* as defined by the bilingual's proficiency level in two languages, *linguistic relationship* between the bilingual's two languages, and *coding language* which means whether subjects write stimulus items in their dominant or weaker language. The bilingual dual coding model proposed by Paivio & Desrochers (1980) plus the later revision of the model by Hamers & Blanc (1989) served as the conceptual framework of this study. Finally, the idea of *depth of processing* (Craik & Lockhart, 1972; Bradshaw & Anderson, 1982) was introduced as a necessary consideration in understanding certain patterns of memory representation found with unbalanced bilinguals.

In this study, to examine memory representation across proficiency levels in the two languages of the bilingual (*degree of bilinguality*), subjects were recruited not only from balanced bilinguals who could speak both languages fluently, but also among unbalanced bilinguals which, for purposes of this study, meant individuals who possessed a high level of proficiency in one language, but not the other. Thus three different bilingual proficiency groups were formed based on the subject's degree of bilinguality. In order to examine the influence of the *linguistic relationship* (similarities or differences) of the bilingual's two languages on memory recall, two different bilingual groups were compared: Korean-English and Spanish-English bilinguals. Since Spanish and English are linguistically closer to each other in various aspects than are Korean and English, the comparison of these two bilingual groups will inform us of the possible effects that

linguistic differences may have on memory representation in these two bilingual populations. Finally, I examined the effect of the *coding language* on memory recall especially in the case of unbalanced bilinguals by asking the subjects to write, that is, to code half of the stimulus items in their dominant language and the remaining half in their weaker language.

Method

Subjects

Total of 340 subjects participated in this study. There were 164 Korean-English bilingual subjects and 176 Spanish-English bilingual subjects. Among these, 176 were female subjects (70 in the Korean group and 106 in the Spanish group) and 164 were males (94 in the Korean group and 70 in the Spanish group). Most of the subjects were recruited around Stanford University and 282 were either undergraduate or graduate students at Stanford or UC Berkeley (126 for the Korean group and 156 for the Spanish group) and 58 were either spouses of students, secondary school students, or members of the community whose educational level was similar to Stanford students. All subjects were college students or graduates (B.A. degree or higher) except 7 secondary school students (6 for the Korean group and 1 for the Spanish group). In the Korean group, 136 subjects were born in Korea while 25 were born in the U.S. On the other hand, the Spanish bilinguals came from different countries including: 84 were born in the U.S., 43 from Mexico, 32 from South American countries, 11 from Europe, and 6 from other countries.

The mean age of the Korean subjects was 26.8 (26.2 for females and 27.2 for males) and 25.4 for the Spanish group (24.7 for females and 26.4 for males). There was no age difference between the Korean and Spanish groups and also no age difference between male and female subjects in both language groups. However, there was a significant age difference between student and non-student subjects in both groups (for the Korean group, $t(161) = 8.553$, $p < .0001$; for Spanish group, $t(171) = 5.531$, $p < .0001$). Students were significantly younger (24.7 for the Korean group and 24.5 for the Spanish group) than non-student subjects (33.8 for the Korean group and 32.8 for the Spanish group).

Two basic criteria were used to recruit subjects for this study. The first was that subjects had to be fluent with native-like proficiency in at least one of their languages. The second criterion was that subjects had to be literate in both languages because the study required some minimum level of literacy. In order to obtain a proficiency level of the two languages of each subject, a subjective measure of proficiency based on a self-judgment method was used. In a questionnaire (see the attached Proficiency Questionnaire at the back of Appendix 6), subjects were asked to judge their English and Korean (or Spanish) proficiency along four different skills (listening, speaking, reading, and writing). Subjects were given forty situations and asked to rate their proficiency on a five-point Likert scale of how well they could use both languages in each situation. A detailed description of how to develop the Proficiency Questionnaire is provided in Appendix 6. The statistical procedures used to develop the proficiency scales are also described in Appendix 6.

Based on the proficiency ratings, subjects were categorized into three different proficiency groups: Korean (or Spanish)-dominant group, Balanced group, and English-dominant group. From a total of 164 Korean-English bilingual subjects, 72 were Korean-dominant unbalanced bilinguals, 37 were Balanced bilinguals, and 55 were English-dominant unbalanced bilinguals. Further, of the 176 Spanish-English bilingual subjects, 24 were categorized as Spanish-dominant unbalanced bilinguals, 81 were Balanced, and 71 were grouped as English-dominant unbalanced bilinguals.

Materials

Stimulus items (sixty words in three languages; English, Korean, and Spanish, and their pictorial representation) which were selected in Study II (Item Selection Study) were used. These stimulus items (see Appendix 5) were carefully selected based on three variables: (a) picture clarity, (b) word familiarity in all three language groups, and (c) words that evoke high imagery. Borrowed or cognate words (e.g., piano; violin; camara) were omitted during the item selection procedure despite of their high quality pictorial representation because these items may influence memory recall and recognition (De Groot & Nas, 1991), which are required in this study. Pictures that could evoke one or many synonyms or different names (e.g., frog/toad; airplane/plane; paraguas/sombrilla) were also excluded from the stimulus item list, even though they were very common and familiar words, because they could also influence memory recall and recognition. Each of the selected sixty items were prepared as 1" × 1" slides in four different ways: (a) as a picture,

(b) as an English word, (c) as a Korean word, and (d) as a Spanish word. These slides were prepared for use on a standard Carousel projector.

Sixty items were randomly assigned into six groups (ten items in each group) because this study requires six different conditions based on three different modes of item presentation (in picture, in English, and in another language) and two different coding requests. Thus this study constitutes a 3×2 within-subjects design. The six conditions are summarized as followings:

Condition	Stimulus Presenting Mode	Coding Request
1.	picture	give a name in English
2.	word in Korean (or Spanish)	translate it to English
3.	word in English	copy it in English
4.	picture	give a name in Korean (or Spanish)
5.	word in English	translate it to Korean (or Spanish)
6.	word in Korean (or Spanish)	copy it in Korean (or Spanish)

In this study, two different coding requests were incorporated into the procedure: one asked subjects to write in English and the other was to write in another language. The rationale for adding this variable was to assess the effect of coding language on memory recall. For example, English would be a weaker language for unbalanced bilinguals who are dominant in another language (Korean or Spanish), or it would be the stronger language for unbalanced English-dominant bilinguals. It was predicted that subjects would recall more items when they coded items in their weaker language.

Six different stimulus item lists were made with the same sixty items in order to give each of the sixty items a chance to be presented in each of the three modes and also to give them a chance to be given in both coding conditions. Thus the first list was generated by a random assignment of ten items in each of the above six conditions. Five other lists were produced by systematically changing the order of the above six conditions. Items in each list were then randomly arranged for the order of their presentation in the study.

Procedures

Subjects were tested either individually or in small groups. Subjects were first asked to fill out a background questionnaire which asked age, country of birth, first

language, current dominant language, other languages spoken, educational history. Subjects were then asked to follow the direction to complete the main study which consisted of three different tasks: (1) coding, (2) incidental recall, and (3) recognition of the mode of presentation. Since this study required an incidental memory recall, subjects were not told that they would be asked to recall the items at a later time. Between the coding and recall tasks, subjects were asked to complete a language-proficiency self-rated questionnaire for the purpose of measuring their proficiency level in the two languages.

Task 1 (Coding Task). In Task 1, subjects were told that there would be 60 items shown on slides: 20 would be pictures, 20 English words, and 20 Korean (or Spanish) words. Subjects were asked to write (code) half of the items (30 items) in English and the other half in Korean (or Spanish). Subjects were given one of the six randomly prepared stimulus item lists. The order of writing the stimulus items in either English or Korean (or Spanish) was controlled so that half of the subjects were asked to write in English first and the other half of the subjects were directed to write in the other language (Korean or Spanish) first.

For example, let's assume that a subject was requested to write in English for the first block of 30 items and in the opposite language for the second 30-item block. For the first 30 items, if the subject saw a picture then s/he was to write the picture's name in English, if the subject saw a Korean (or Spanish) word then s/he was to translate it in English, and if s/he saw an English word then the task required copying the word in English. On the other hand, for the last 30 items, the subject was asked to name the picture in Korean (or Spanish), translate an English word into Korean (or Spanish), and copy a Korean (or Spanish) word as it was. If the subject was asked to write in Korean (or Spanish) for the first 30 items and in English for the last 30 items, then the order of the coding language was reversed. Before the actual experiment began, three example stimulus items were shown on slides with an instruction for subjects to practice the procedure and an opportunity was given to subjects to ask any questions concerning this task. Each slide was shown for 5 seconds. Although short, the interval was sufficient for subjects to complete their coding response for each item presentation. It took about five minutes to complete Task 1.

Following completion of Task 1, subjects were asked to complete a questionnaire in which the subject's language proficiency in English and Korean (or Spanish) was measured. The experimental procedure required that all subjects have 10 minutes between Task 1 and Task 2. Thus, completing a questionnaire at this point in the study served the

purpose of filling the required time interval between tasks. All subjects completed the questionnaire in the desired time of 10 minutes following Task 1.

Task 2 (Incidental Recall Task). In Task 2, subjects were asked to recall as many of the items that they had written down during the Coding Task (Task 1). They were asked to recall the items in the same language that they had used to write down the items while they were completing Task 1, regardless of the stimulus mode presented on the screen. Five minutes were given to subjects to complete this task. Subjects were then asked whether they had ever expected the recall task to occur while they were completing the Coding Task.

Task 3 (Recognition of presenting mode). In Task 3, subjects were given a list of sixty items which had been presented in Coding Task (Task 1). Every item was, this time, written in both English and Korean (or Spanish) and shown in an alphabetical order. Subjects were asked to indicate the stimulus mode for each item presented on the screen during the Coding Task, regardless of what language they had actually used to write it down: i.e., "P" for items presented in a picture, "E" for items presented in an English word, or "K" (or "S") for items presented in a Korean (or Spanish) word. Subjects were given five minutes to complete this task.

Results

Results of Task 1 (Coding Task)

The number of items that was coded (i.e., successfully written down as requested) in Task 1 was analyzed by coding condition (Picture-Naming, Translation, and Copying conditions) and coding language (English or Korean/Spanish) between the three proficiency groups (English-dominant, Balanced, and Korean/Spanish-dominant groups). Coding data for each of the two language groups (Korean-English and Spanish-English bilingual groups) was first separately analyzed, then between-group comparisons were performed. Analysis of Task 1 showed that respondents differed on the number of coded items depending on their level of proficiency in the two languages. If only balanced bilinguals had been used in this coding task, I would have expected all subjects to have been able to successfully code every item. However, since unbalanced bilinguals were included in the experimental design, I found a different pattern of coding results for the

unbalanced bilinguals. Overall, the unbalanced bilinguals coded fewer items when the task involved using their weaker language. A detailed discussion of the analysis and results of Task 1 is provided in Appendix 7.

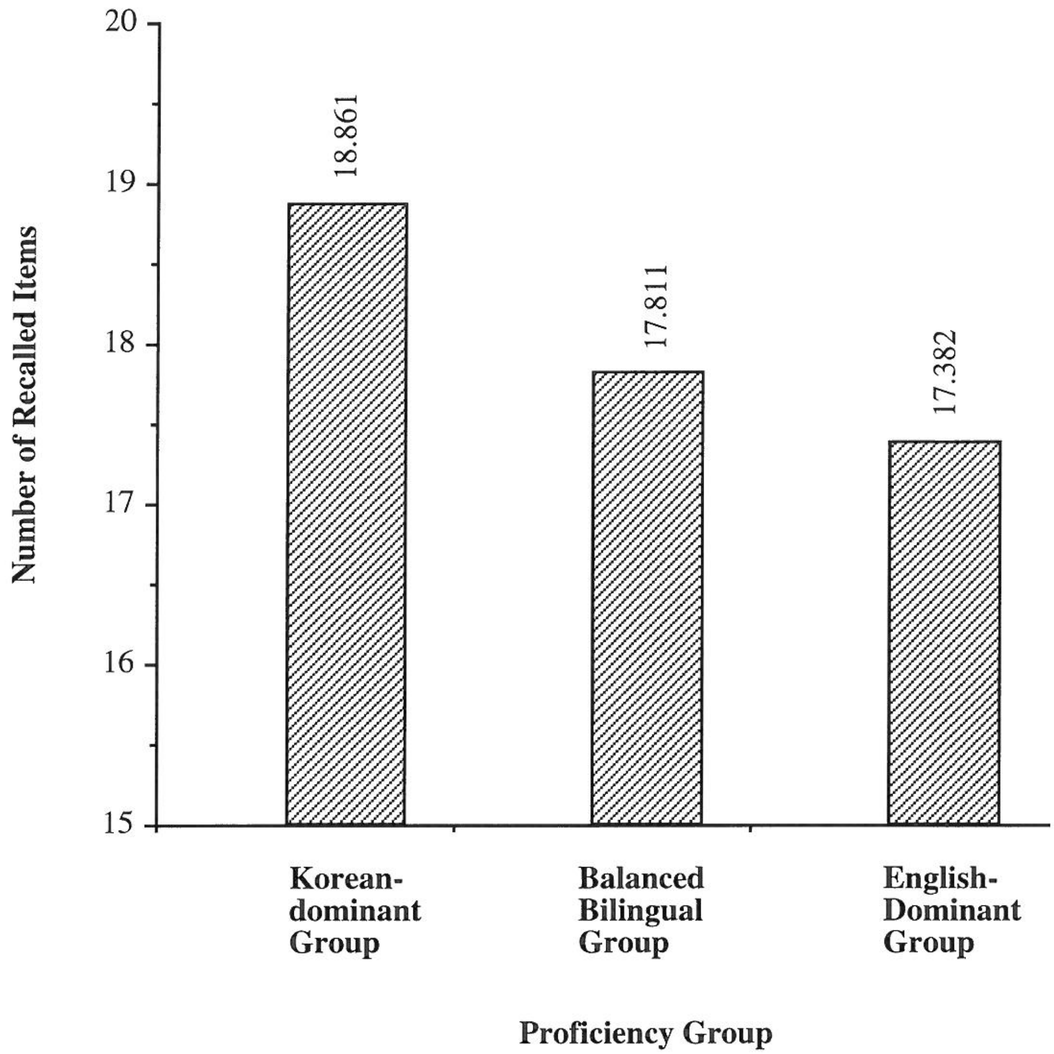
Results of Task 2 (Recall Task)

The number of recalled items in Task 2 was analyzed by coding conditions (Picture-Naming, Translation, and Copying conditions) between the three proficiency groups (English-dominant, Balanced, and Korean/Spanish-dominant groups). Since the half of the 60 items were asked to be coded in English and the other half in Korean (or Spanish) in the Coding Task, and subjects were asked to recall the item, in Task 2, in the same language they wrote down during the Coding Task, the comparison was also computed by recall language as well as with other two variables. Recall data for each of the two bilingual groups (Korean-English and Spanish-English bilingual groups) was first separately analyzed, then compared between the two groups.

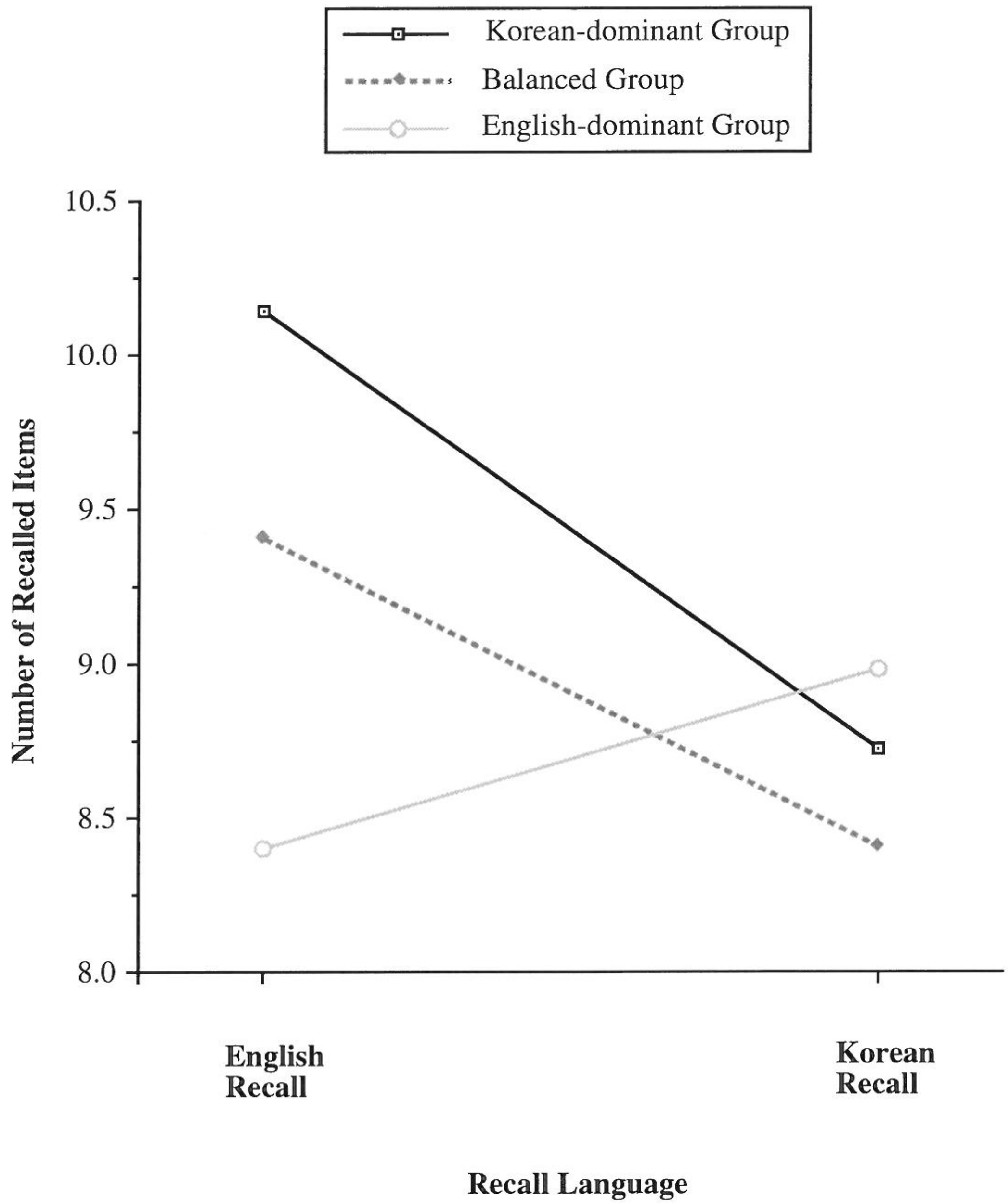
Korean-English bilingual recall results. There was no significant difference in total number of recalled items in Task 2 between the three different proficiency groups (see Figure 5-2-1). However, there was a significant difference in number of recalled items between English recall (M = 9.39) and Korean recall (M = 8.74), t (163) = 2.192, $p = .03$. The pattern of the difference in number of recalled items between the two languages also differed according to the subject's proficiency group (see Figure 5-2-2). A two-way ANOVA (Analysis of Variance) for recall language and proficiency group showed a significant difference in the number of recalled items by recall language, F (1, 161) = 4.100, $p = .045$, and also revealed a significant interaction between the two variables, recall language and proficiency group, F (2, 161) = 4.689, $p = .01$.

Overall, more items were recalled in English than in Korean, but when the mean number of recalled items in each language was examined by the three proficiency groups, it was evident that more items were recalled in English for the Korean-dominant and Balanced groups, whereas more Korean items were recalled for the English-dominant group. This interaction effect is shown in Figure 5-2-2. The difference in number of recalled items was examined between English and Korean for each of the proficiency groups. The mean number of English-recalled items for the Korean-dominant group (M = 10.14) was significantly higher than Korean-recalled items (M = 8.72), t (71) = 3.530, $p = .001$. For the Balanced group, the mean number of English items recalled was 9.41

[Figure 5-2-1] Total Mean Difference in Number of Recalled Items for the Three Korean Proficiency Groups



[Figure 5-2-2] Mean Difference in Number of Recalled Items for the Three Korean Proficiency Groups by Recall Language



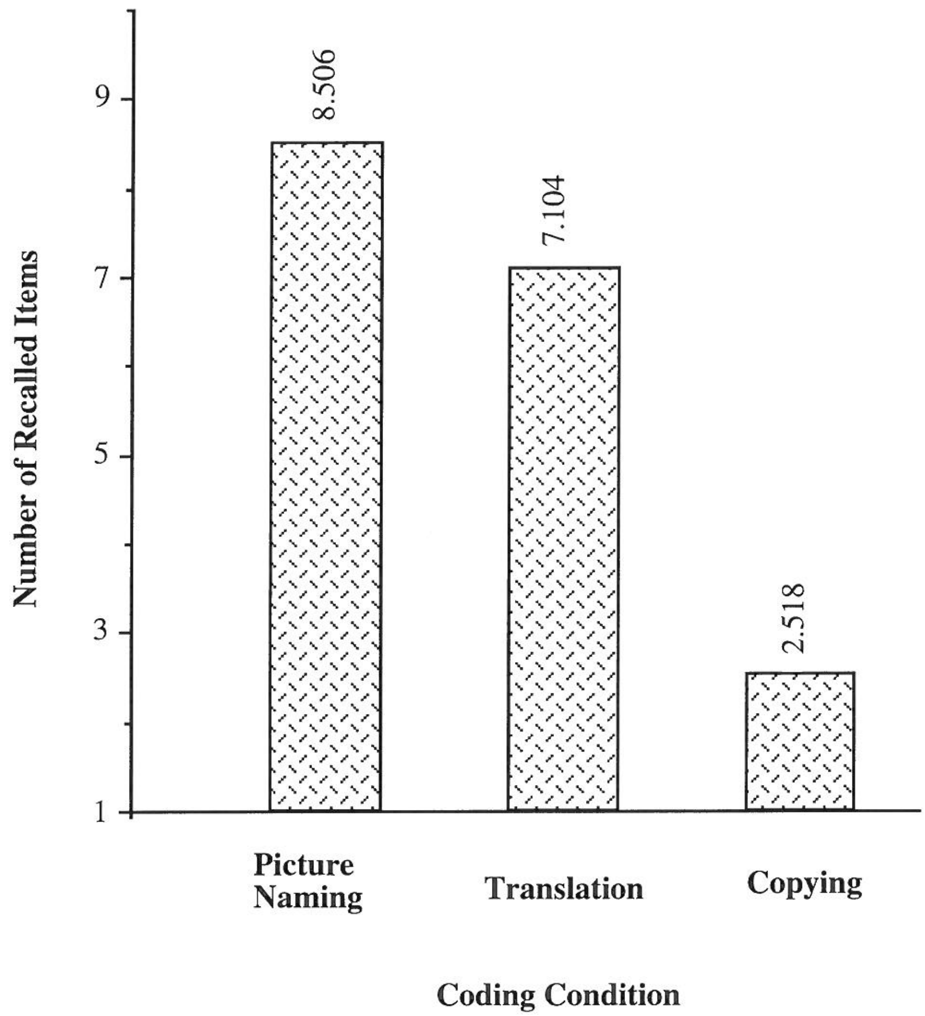
and 8.41 for Korean items; for the English-dominant group, the mean number for English was 8.40 and 8.98 for Korean. Even though no statistically significant difference was found in number of recalled items between Korean and English for the Balanced and English-dominant groups, a significant interaction effect was found for recall language and proficiency group because recall for the English-dominant group was higher in Korean while the Balanced and Korean-dominant groups recalled more English items.

Figure 5-2-2 also depicts the difference in number of recalled items between the three proficiency groups. In English recall, there was a significant difference in number of recalled items between the three proficiency groups, $F(2, 161) = 5.168$, $p = .007$. Tukey's HSD multiple comparisons revealed that the only significant difference was found between the Korean-dominant and English-dominant groups, $p = .004$. The mean number of recalled items for the English-dominant group ($M = 8.40$) was significantly lower than that of the Korean-dominant group ($M = 10.14$), $t(125) = 3.147$, $p = .002$. However, there was no significant difference between the three proficiency groups in their recall of Korean items.

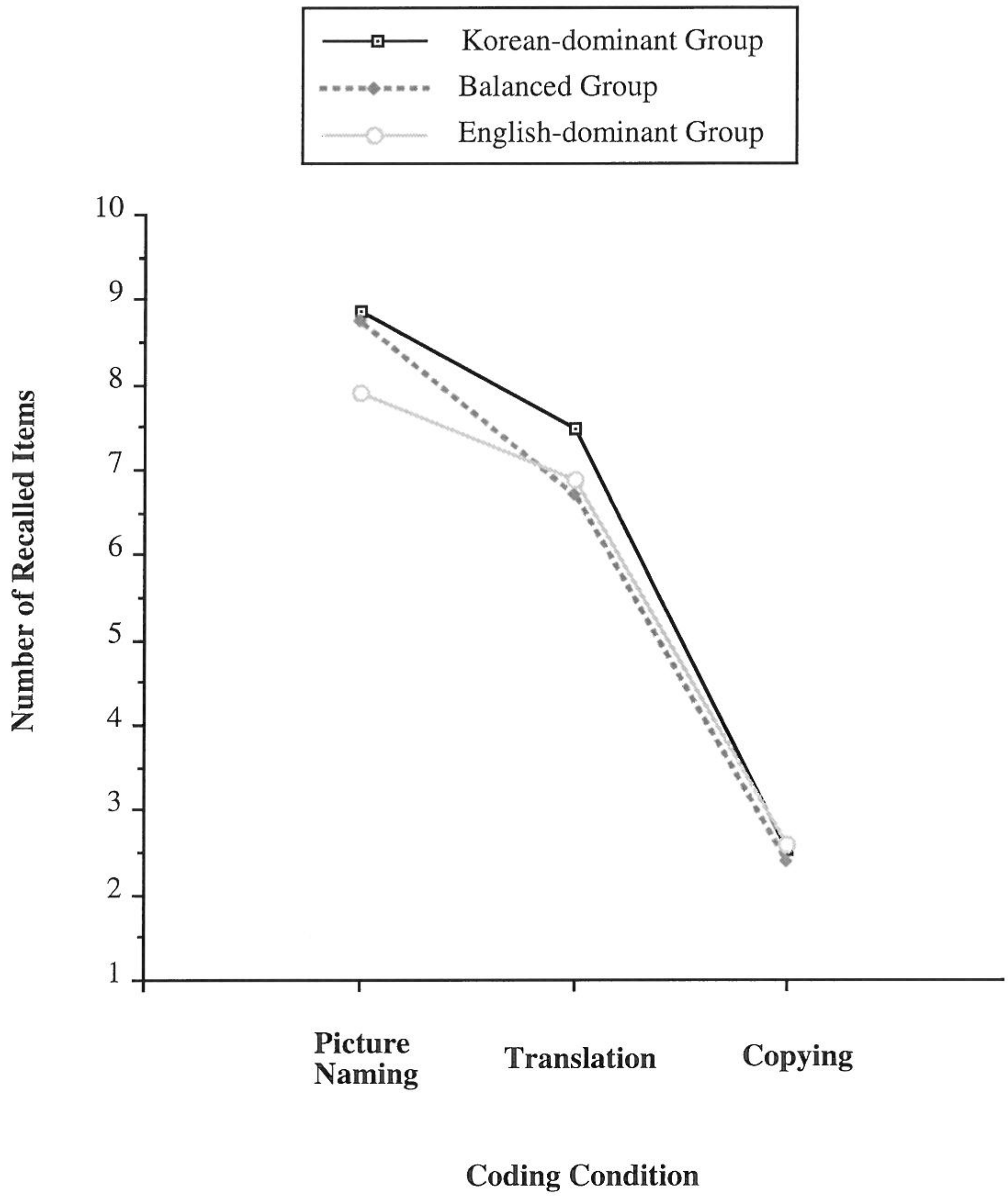
The mean number of recalled items was now compared by coding condition. As can be seen in Figure 5-2-3, there was a significant difference in number of recalled items by coding condition, $F(2, 326) = 395.323$, $p < .0001$. The mean number of recalled items in the Picture-Naming condition was 8.51 and that of the Translation and Copying conditions was 7.10 and 2.52, respectively. Paired comparisons were next computed between the different coding conditions. A significant difference was found in number of recalled items: between the Picture-Naming and Translation conditions, $t(163) = 5.875$, $p < .0001$; between the Picture-Naming and Copying conditions, $t(163) = 29.332$, $p < .0001$; and also between the Translation and Copying conditions, $t(163) = 20.467$, $p < .0001$.

In order to see the difference in number of recalled items by coding condition and proficiency group, a two-way ANOVA was calculated. There was no significant between-group difference for proficiency group in number of recalled items (see Figure 5-2-4). However, a significant within-group difference by coding condition was found, $F(2, 322) = 367.735$, $p < .0001$, with the Picture-Naming condition resulting in the most recalled items and the poorest recall occurring in the Copying condition. There was no significant interaction in number of recalled items between coding condition and proficiency group.

[Figure 5-2-3] Mean Difference in Number of Recalled Items by Coding Condition



[Figure 5-2-4] Mean Difference in Number of Recalled Items between Coding Conditions for Three Korean Proficiency Groups

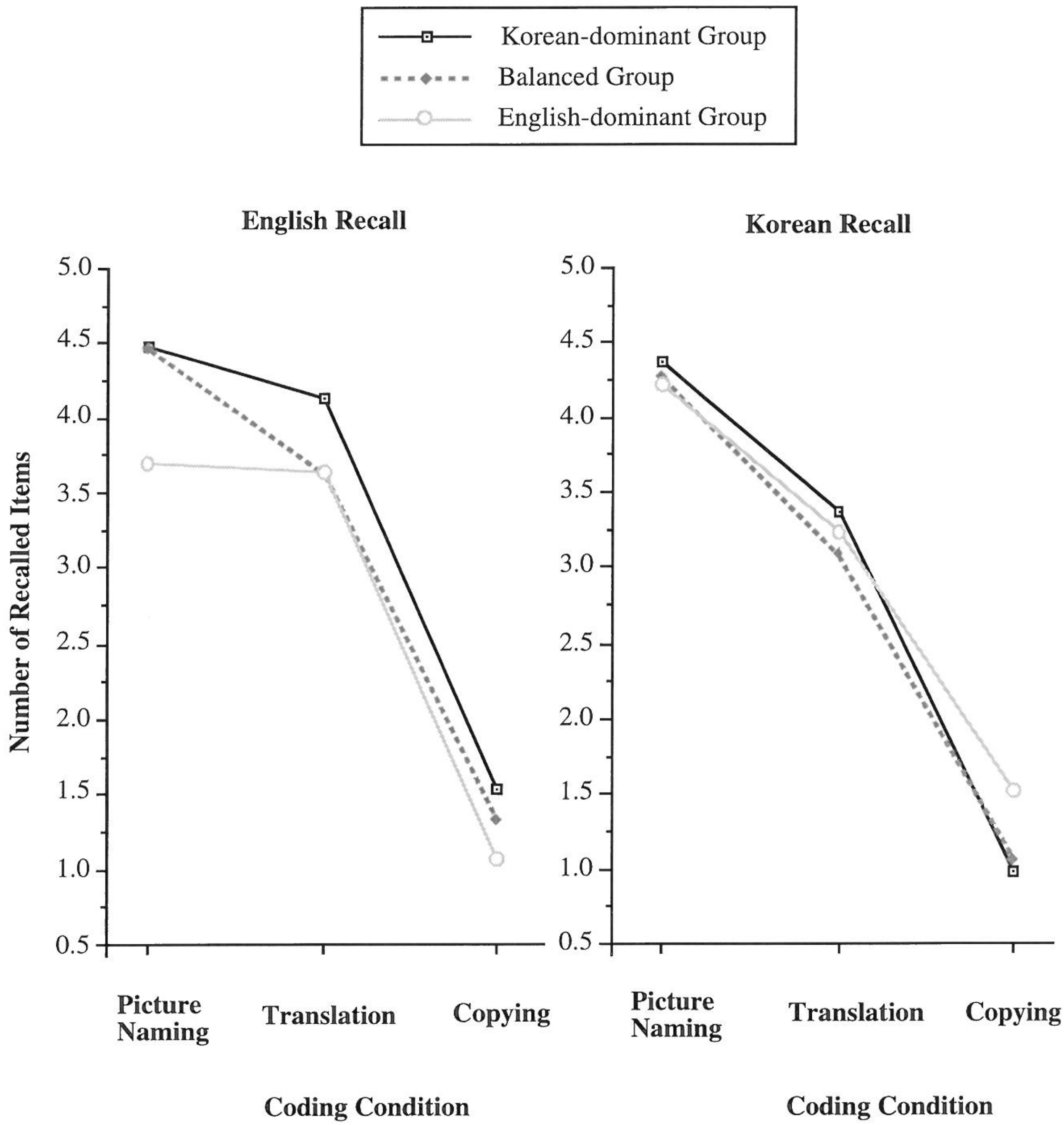


The mean difference in number of recalled items between the three coding conditions was now examined for each of the three proficiency groups (see also Figure 5-2-4). For the Korean-dominant group, there was a significant difference in number of recalled items between the coding conditions, $F(2, 142) = 176.247$, $p < .0001$. The mean number of recalled items in the Picture-Naming condition ($M = 8.85$) was significantly higher than that of the Translation condition ($M = 7.49$), $t(71) = 3.557$, $p = .001$, and the Copying condition ($M = 2.53$), $t(71) = 20.938$, $p < .0001$. The mean number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, $t(71) = 13.296$, $p < .0001$. For the Balanced group, a significant difference in number of recalled items was also found between the coding conditions, $F(2, 72) = 107.081$, $p < .0001$. The mean number of recalled items in the Picture-Naming condition ($M = 8.73$) was significantly higher than that of the Translation condition ($M = 6.70$), $t(36) = 5.142$, $p < .0001$, and the Copying condition ($M = 2.38$), $t(36) = 13.156$, $p < .0001$. The mean number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, $t(36) = 9.639$, $p < .0001$. For the English-dominant group, there was again a significant difference in number of recalled items between the coding conditions, $F(2, 108) = 118.534$, $p < .0001$. The mean number of recalled items in the Picture-Naming condition ($M = 7.91$) was significantly higher than that of the Translation condition ($M = 6.87$), $t(54) = 2.417$, $p = .019$, and the Copying condition ($M = 2.60$), $t(54) = 16.712$, $p < .0001$. The mean number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, $t(54) = 12.538$, $p < .0001$

In order to see the difference in number of recalled items across all three variables: recall language, proficiency group, and coding condition, a three-way ANOVA was performed. The results showed that there was no significant between-group difference in number of recalled items for proficiency group as a main effect. However, there was a significant difference in number of recalled items between the two recall languages, $F(1, 161) = 4.100$, $p = .045$, and between the three coding conditions, $F(2, 322) = 367.735$, $p < .0001$. A significant interaction was found between recall language and proficiency group, $F(2, 161) = 4.689$, $p = .01$, and also between recall language and coding condition, $F(2, 322) = 3.906$, $p = .021$. However, there was no interaction between coding condition and proficiency group nor a three-way interaction between the variables.

In English recall, as can be seen in Figure 5-2-5, there was a significant difference in number of recalled items by proficiency group, $F(2, 161) = 5.168$, $p = .007$. There

[Figure 5-2-5] Mean Difference in Number of Recalled Items by Recall Language, Proficiency Group, and Coding Condition



was also a significant difference in number of recalled items by coding condition, $F(2, 322) = 179.858$, $p < .0001$. No significant interaction was found between coding condition and proficiency group. A significant proficiency group difference was found in English recall, even though no significant difference had been found between the proficiency groups when the number of recalled items in both languages together had been compared as can have been seen in Figure 5-2-4. This different finding resulted from a significant interaction effect between the recall language and proficiency group.

A test for mean difference effect showed that the significant difference between the proficiency groups occurred only in the Picture-Naming condition, $F(2, 161) = 4.346$, $p = .015$ (see Figure 5-2-5), but not in other two conditions. Tukey's HSD multiple comparisons showed that there was a significant difference in number of recalled items between the English-dominant and Korean-dominant groups, $p = .017$, in the Picture-Naming condition. The difference in number of recalled items between the English-dominant and Balanced groups was noticeable, although not significant, $p = .060$. The mean number of recalled items for the English-dominant group ($M = 3.69$) was significantly lower than that of the Korean-dominant group ($M = 4.47$), $t(125) = 2.728$, $p = .021$, and also lower, but not significantly though, than that of the Balanced group ($M = 4.46$), $t(90) = 2.276$, $p = .075$. There was no significant difference between the Balanced and Korean-dominant groups. In the Translation condition, there was no significant difference in number of recalled items between the proficiency groups, although the mean number of recalled items for the Korean-dominant group ($M = 4.13$), as we can seen in Figure 5-2-5, was greater than that of the Balanced ($M = 3.62$) and English-dominant groups ($M = 3.64$). In the Copying condition, no significant difference in number of recalled items was found between the three proficiency groups, although a trend was noted, $F(2, 161) = 2.384$, $p = .095$. Tukey's HSD multiple comparisons showed that a mean difference in number of recalled items between the Korean-dominant and English-dominant groups was noticeable, while not significant ($p = .074$), and did indicate a trend with the Korean-dominant group having a higher mean recall.

The mean difference between the three coding conditions in English recall was also examined for each of the three proficiency groups (see also Figure 5-2-5). For the Korean-dominant group, there was a significant difference in number of recalled items between the coding conditions, $F(2, 142) = 98.235$, $p < .0001$. The mean number of recalled items in the Copying condition ($M = 1.54$) was significantly lower than that of the Picture-Naming condition ($M = 4.47$), $t(71) = 13.235$, $p < .0001$; and the Translation condition ($M =$

4.13), t (71) = 11.601, $p < .0001$. But no significant difference was found between the Picture-Naming and Translation conditions. For the Balanced group, there was also a significant difference in number of recalled items between the coding conditions, F (2, 72) = 45.868, $p < .0001$. The mean number of recalled items in the Picture-Naming condition (M = 4.46) was significantly higher than that of the Translation condition (M = 3.62), t (36) = 2.285, $p = .028$, and the Copying condition (M = 1.32), t (36) = 10.519, $p < .0001$. The number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, t (36) = 6.593, $p < .0001$. For the English-dominant group, there was again a significant difference in number of recalled items between the coding conditions, F (2, 108) = 53.515, $p < .0001$. The number of recalled items in the Copying condition (M = 1.07) was significantly lower than that of the Picture-Naming condition (M = 3.69), t (54) = 10.218, $p < .0001$, and the Translation condition (M = 3.64), t (54) = 8.672, $p < .0001$. No significant difference in number of recalled items was found between the Translation and Copying conditions.

In Korean recall, as can be also noted in Figure 5-2-5, there was no significant difference in number of recalled items between the proficiency groups. However, there was a significant difference in number of recalled items between the coding conditions, F (2, 322) = 180.955, $p < .0001$. No significant interaction was found between coding condition and proficiency group. A test for mean difference effect showed that there was a noticeable difference in number of recalled items between the proficiency groups in the Copying condition, F (2, 161) = 3.020, $p = .052$, although not significant. The number of recalled items for the English-dominant group (M = 1.53) was noticeably higher than that of the Korean-dominant group (M = .99), t (125) = 2.421, $p = .051$. No other proficiency group difference in number of recalled items attained statistical significance in the Picture-Naming and Translation conditions.

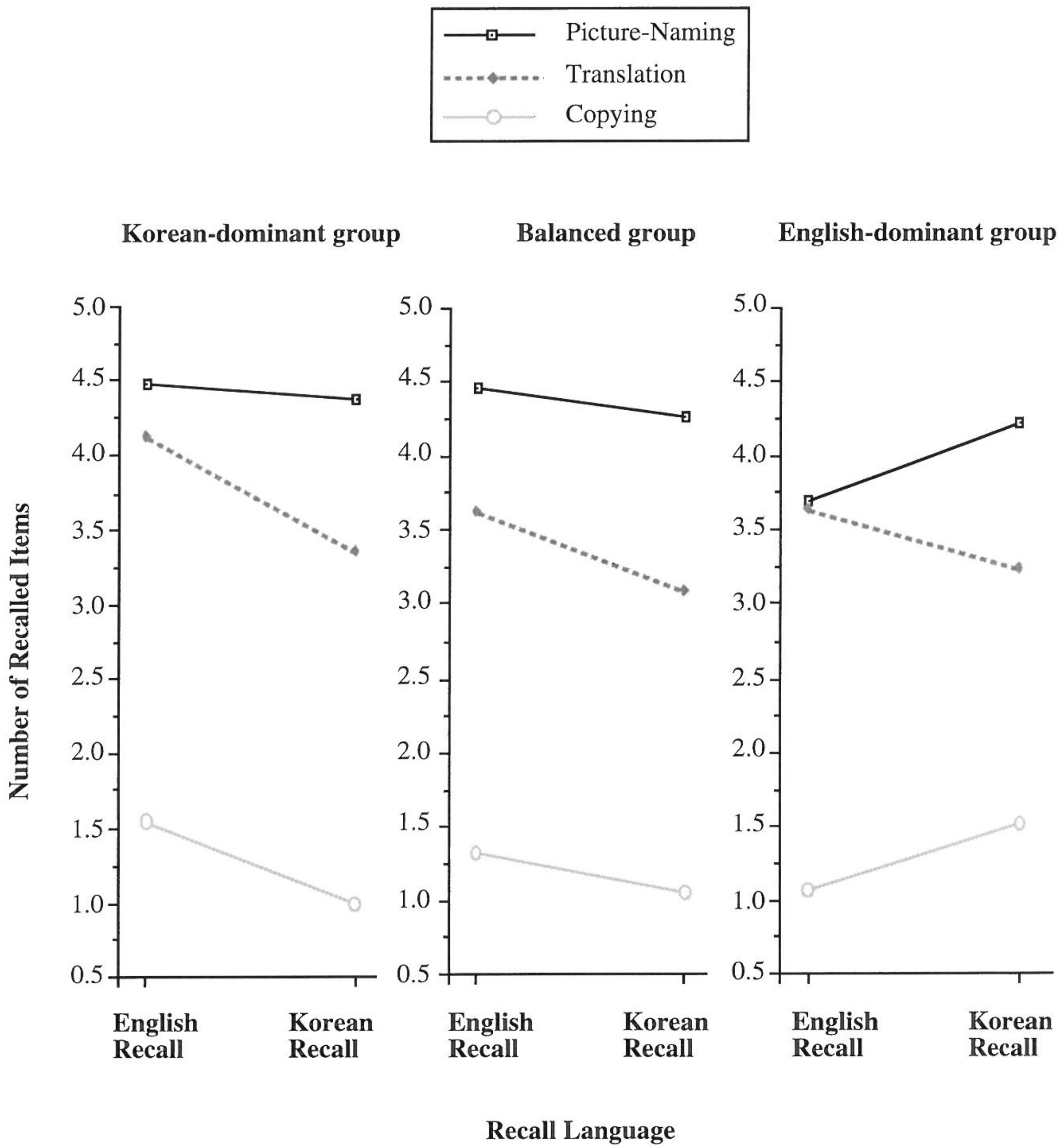
The mean difference between the three coding conditions in Korean recall was also examined for each of the three proficiency groups (see also Figure 5-2-5). For the Korean-dominant group, there was a significant difference in number of recalled items between the coding conditions, F (2, 142) = 85.374, $p < .0001$. The number of recalled items in the Picture-Naming condition (M = 4.38) was significantly higher than that of the Translation condition (M = 3.36), t (71) = 3.3121, $p = .001$, and the Copying condition (M = 0.99), t (71) = 16.295, $p < .0001$. There was also a significant difference between the Translation and Copying conditions, t (71) = 8.633, $p < .0001$. For the Balanced group, a significant difference in number of recalled items was also found between the coding conditions, F (2, 72) = 54.907, $p < .0001$. The number of recalled items in the Picture-

Naming condition (M = 4.27) was again significantly higher than that of the Translation condition (M = 3.08), t (36) = 4.222, $p < .0001$, and the Copying condition (M = 1.05), t (36) = 9.330, $p < .0001$. A significant difference was also found between the Translation and Copying conditions, t (36) = 6.726, $p < .0001$. Similar findings were obtained for the English-dominant group, too. There was a significant difference in number of recalled items between the coding conditions, F (2, 108) = 60.735, $p < .0001$. The number of recalled items in the Picture-Naming condition (M = 4.22) was significantly higher than that of the Translation condition (M = 3.24), t (54) = 3.701, $p = .001$, and the Copying condition (M = 1.53), t (54) = 11.062, $p < .0001$. A significant difference was also found between the Translation and Copying conditions, t (54) = 7.379, $p < .0001$.

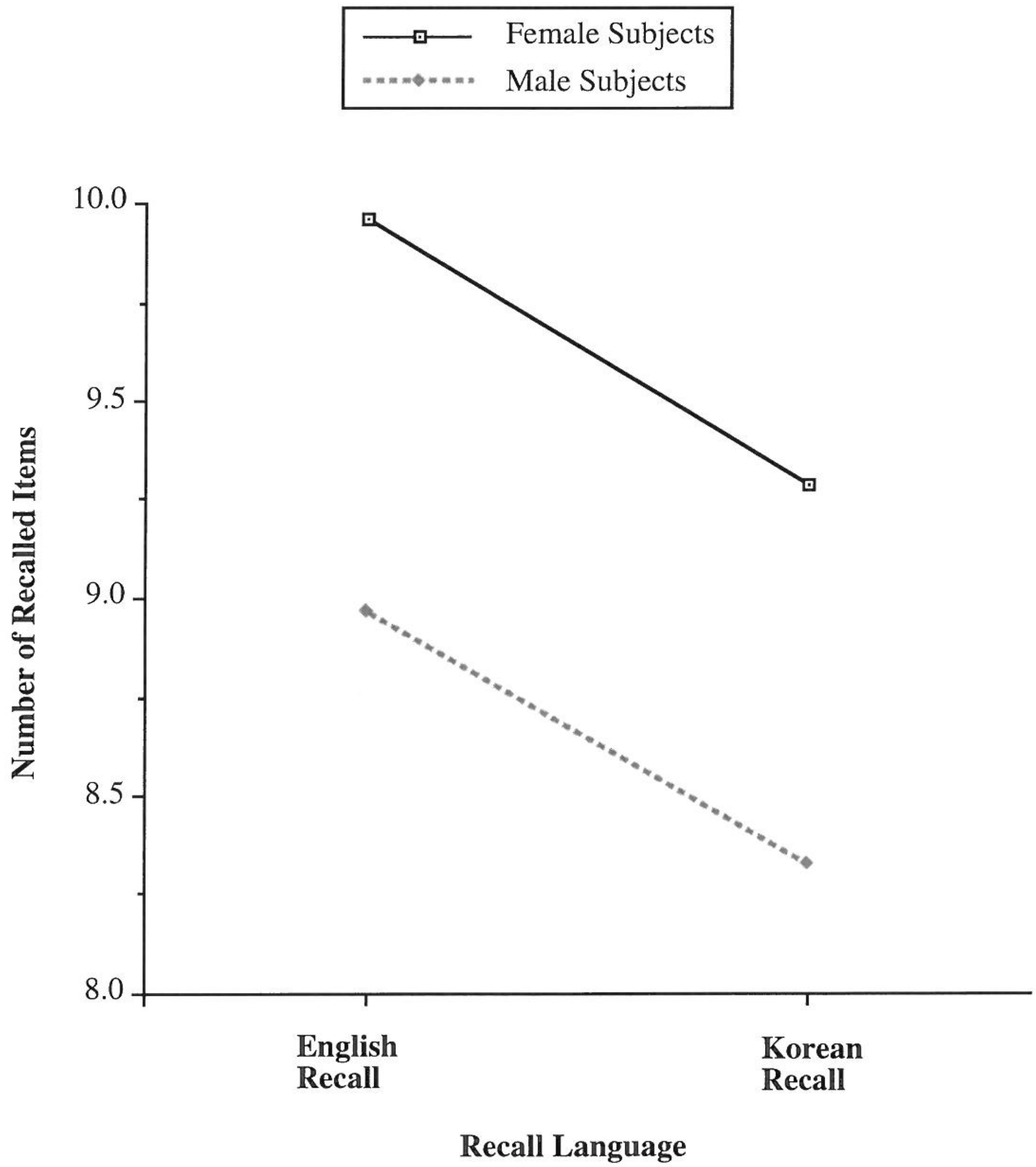
The mean difference in number of recalled items between the two languages was now examined by coding condition for each of the three proficiency groups (see Figure 5-2-6). For the Korean-dominant group, a significant difference in number of recalled items between English and Korean recalls was found in the Translation condition, t (71) = 2.694, $p = .009$, and the Copying condition, t (71) = 3.203, $p = .002$, but not in the Picture-Naming condition. Korean-dominant subjects recalled significantly more items in English than in Korean when the item was in either Translation or Copying condition. There was no significant difference in number of recalled items between the two language recalls for the Balanced group in all three coding conditions. A different pattern of significant results was found for the English-dominant group. The mean number of recalled items in Korean was significantly higher than in English in the Copying condition, t (54) = 2.012, $p = .049$, and the same trend was noted in the Picture-Naming condition although the difference failed to attain the statistical significance, t (54) = 1.783, $p = .08$. No significant difference was found between the two language recalls in the Translation condition. As can be seen in Figure 5-2-6, the pattern of significant difference in number of recalled items was opposite for the Korean-dominant and English-dominant groups: more recall in English for the Korean-dominant group and more recall in Korean for the English-dominant group. However, the Balanced group did not show any significant difference in number of recalled items between the two language recalls.

A significant gender difference was found in total number of recalled items. The mean number of recalled items for female subjects (M = 19.24) was significantly higher than that of male subjects (M = 17.30), t (162) = 2.607, $p = .01$. In English recall, as can be noted in Figure 5-2-7, female subjects (M = 9.96) recalled significantly more items than did the males (M = 8.97), t (162) = 2.043, $p = .043$. A similar finding was found in the Korean recall data: female subjects (M = 9.29) recalled significantly more items than did the

[Figure 5-2-6] Difference in Number of Recalled Items between Two Language Recalls by Coding Condition in Three Korean Proficiency Groups

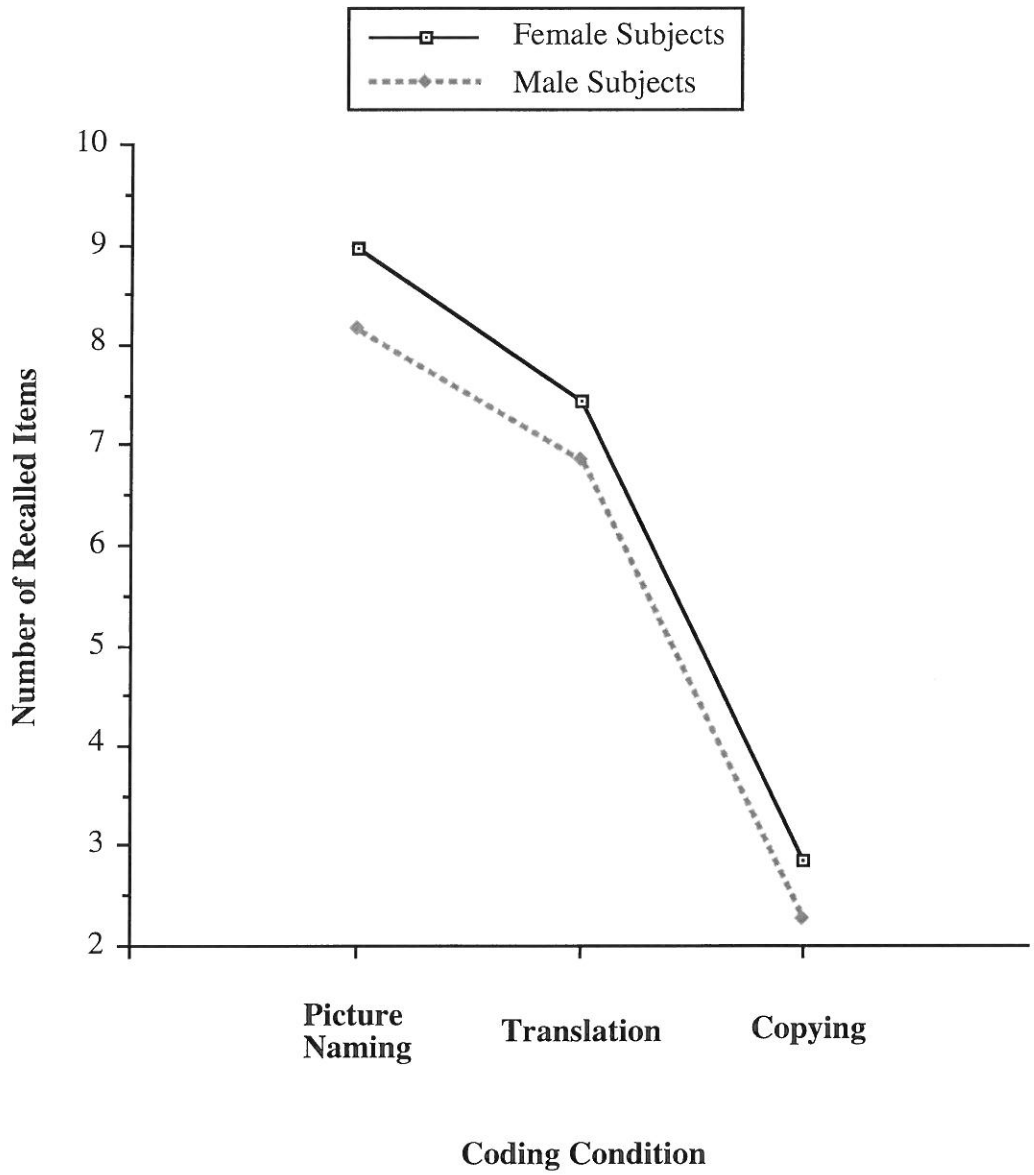


[Figure 5-2-7] Gender Difference in Number of Recalled Items by Recall Language



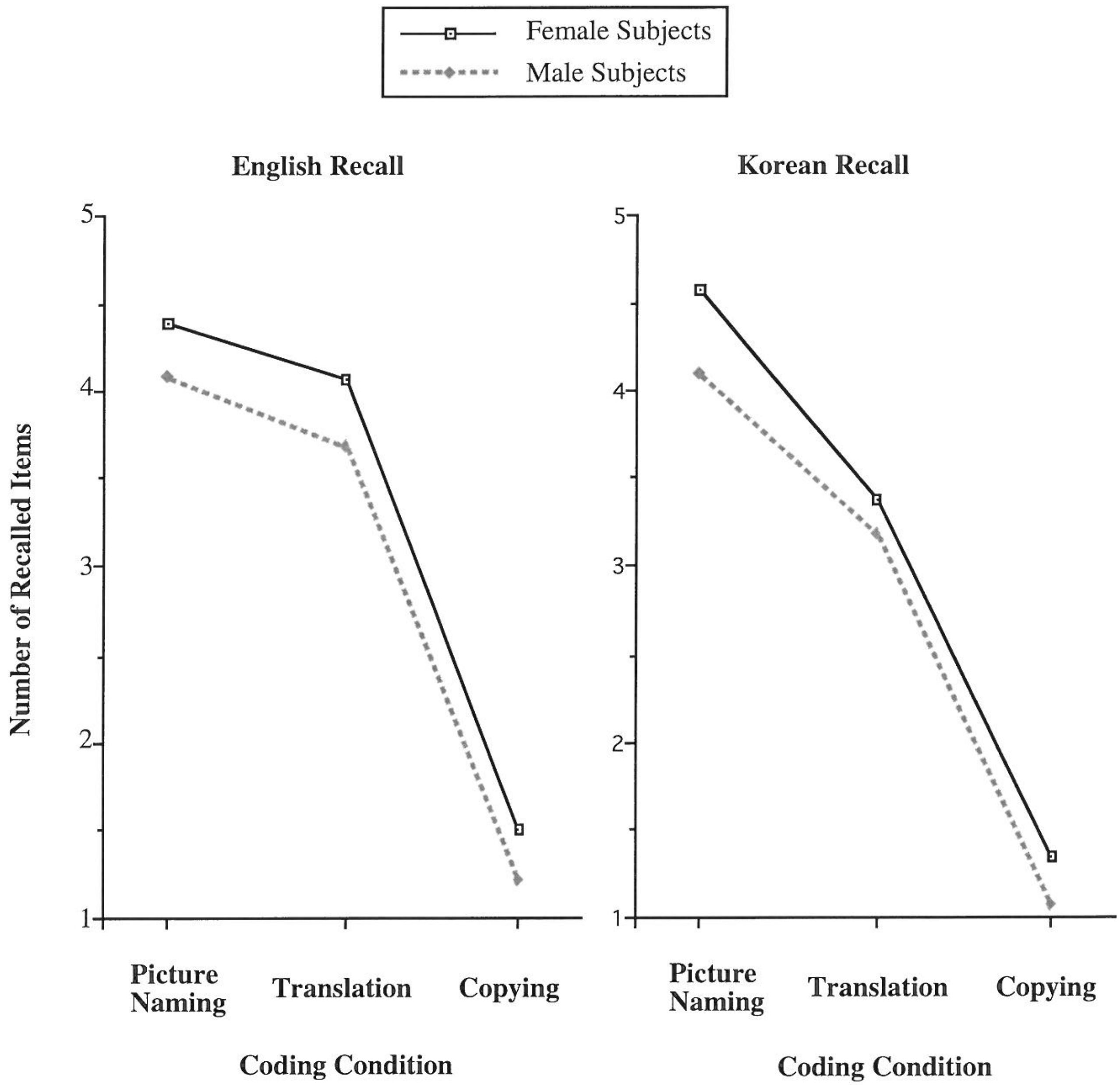
males (M = 8.33), t (162) = 2.011, p = .046. When the number of recalled items was examined by coding condition (see Figure 5-2-8), the gender difference in number of recalled items disappeared in the Translation and Copying conditions, and the only significant gender difference to emerge was found in the Picture-Naming condition.

[Figure 5-2-8] Gender Difference in Number of Recalled Items by Coding Condition



The mean number of recalled items in the Picture-Naming condition for females (M = 8.96) was significantly higher than for males (M = 8.17), t (162) = 2.119, *p* = .036. However, when the number of recalled items was examined by recall language and coding condition together, as can be seen in Figure 5-2-9, the significant difference by gender disappeared,

[Figure 5-2-9] Gender Difference in Number of Recalled Items by Coding Condition and Recall Language



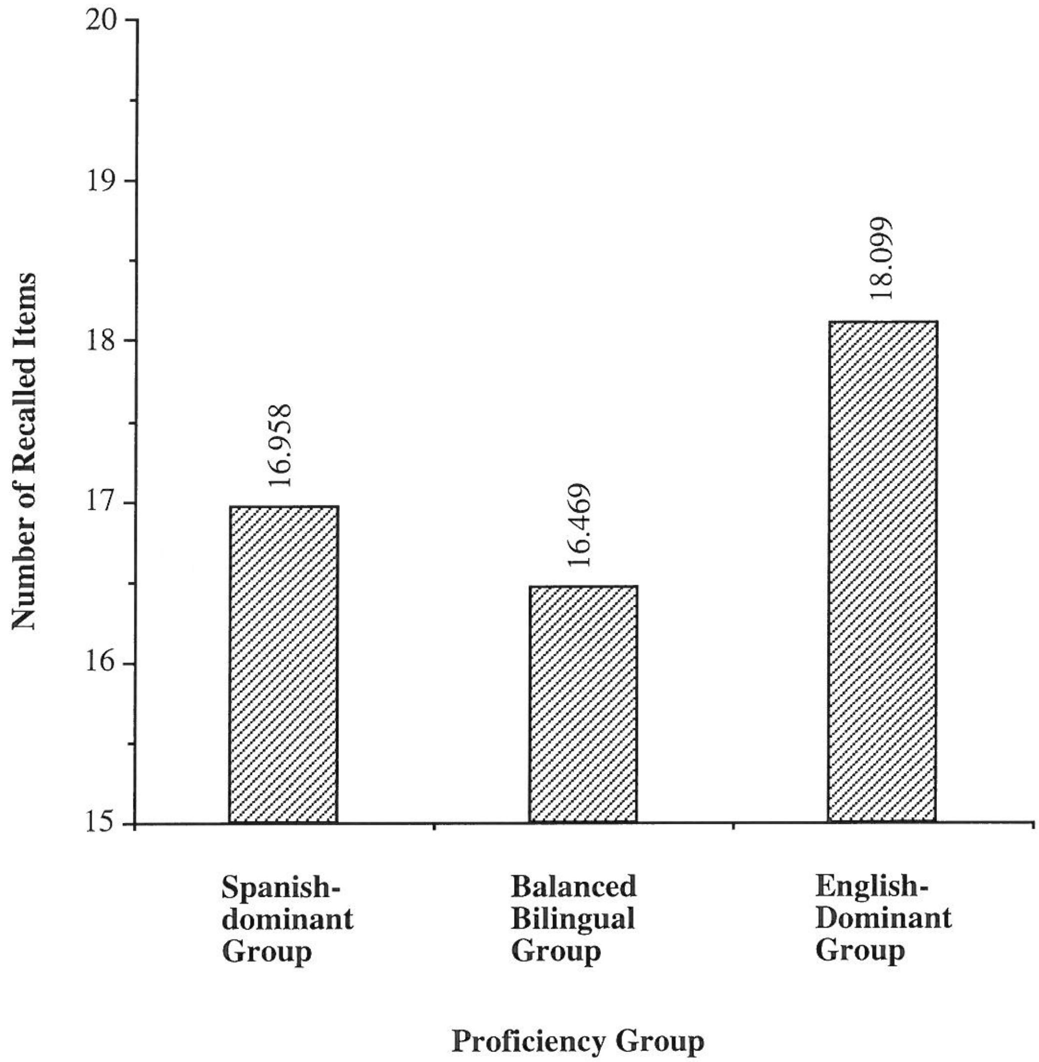
and only in one condition, Picture-Naming condition in Korean recall, females (M = 4.57) recalled more items than did males (M = 4.10) but this difference failed to attain the statistical significance, t (162) = 1.924, p = .056. There was no interaction between gender and any of the other variables.

Spanish-English bilingual recall results. There was no significant difference in total number of recalled items in Task 2 between the three different proficiency groups. However, as can be seen in Figure 5-2-11, there was a noticeable trend of difference between the proficiency groups, $F(2, 173) = 2.489$, $p = .086$. Tukey's HSD multiple comparisons showed that the total number of recalled items for the English-dominant group ($M = 18.10$) was noticeably higher than that of the Balanced group ($M = 16.47$), $p = .069$. A two-way ANOVA for recall language and proficiency group showed that there was no significant difference in number of recalled items between English recall ($M = 8.48$) and Spanish recall ($M = 8.72$), nor significant interaction between recall language and proficiency group (see Figure 5-2-12). However, in Figure 5-2-12, the different pattern of recall can be noted in the two languages between the three proficiency groups even though the difference was not statistically significant. The English-dominant and Balanced groups recalled more items in Spanish, while the Spanish-dominant group recalled more items in English. In Figure 5-2-12, it looked like there was an interaction between recall language and proficiency group but it was not statistically significant.

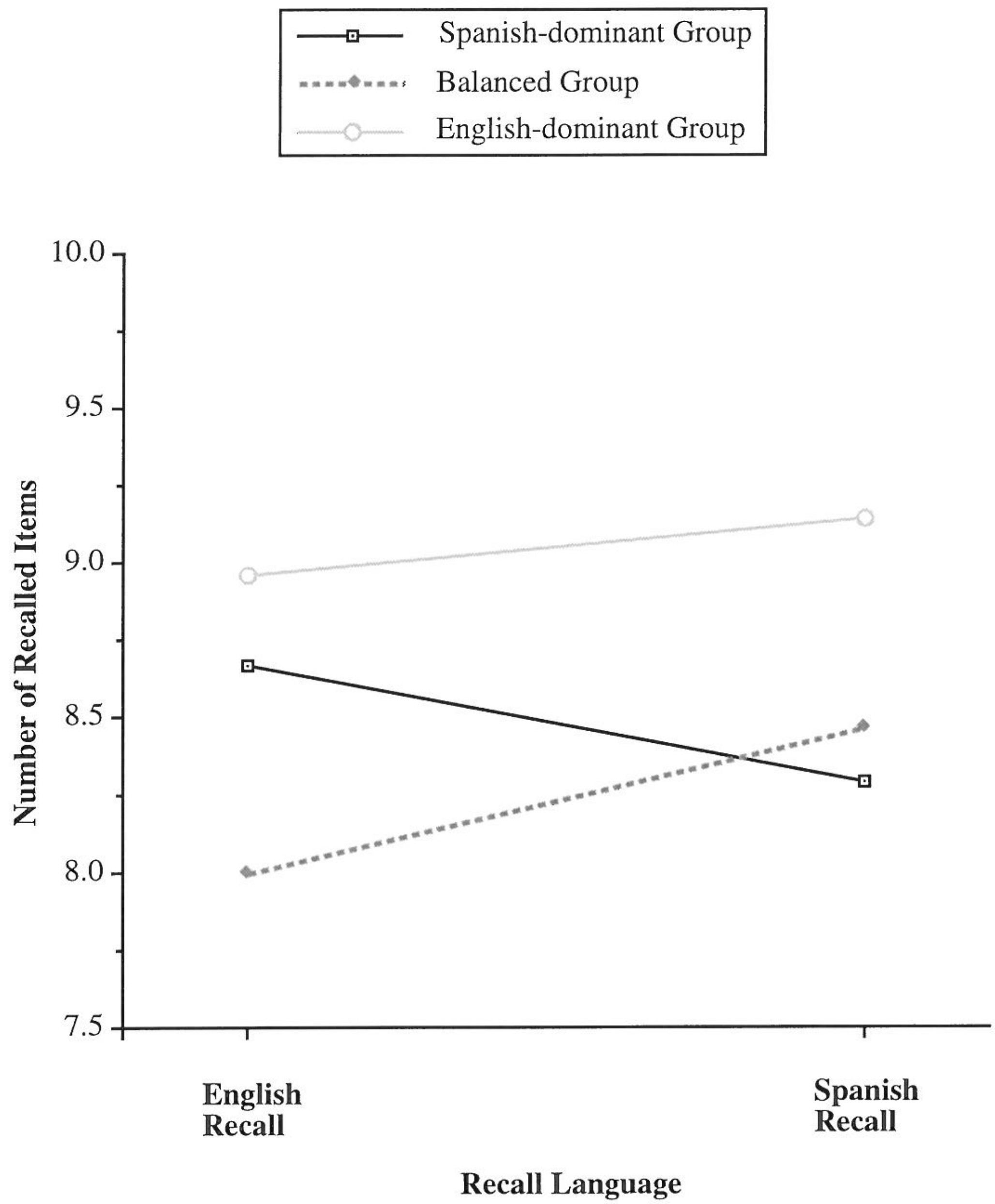
The mean number of recalled items was now compared by coding condition. As can be seen in Figure 5-2-13, there was a significant difference in number of recalled items by coding condition, $F(2, 350) = 239.649$, $p < .0001$. The mean number of recalled items in the Picture-Naming condition was 8.14 and that of the Translation and Copying conditions was 6.05 and 3.00, respectively. Paired comparisons were next computed between the different coding conditions. A significant difference in number of recalled items was found: between the Picture-Naming and Translation conditions, $t(175) = 8.347$, $p < .0001$; between the Picture-Naming and Copying conditions, $t(175) = 22.206$, $p < .0001$; and also between the Translation and Copying conditions, $t(175) = 13.503$, $p < .0001$.

In order to see the difference in number of recalled items by coding condition and proficiency group, a two-way ANOVA was calculated. As we already noted earlier, there was no significant difference in number of recalled items between the proficiency groups (see Figure 5-2-14). However, there was a significant difference in number of recalled items by coding condition, $F(2, 346) = 192.989$, $p < .0001$, with the Picture-Naming condition resulting in the most recalled items and the poorest recall occurring in the Copying condition. There was also a significant interaction between coding condition and proficiency group, $F(4,346) = 3.099$, $p = .016$. This significant interaction effect can be depicted in Figure 5-2-14, and was due to the fact that the pattern of recall in the three

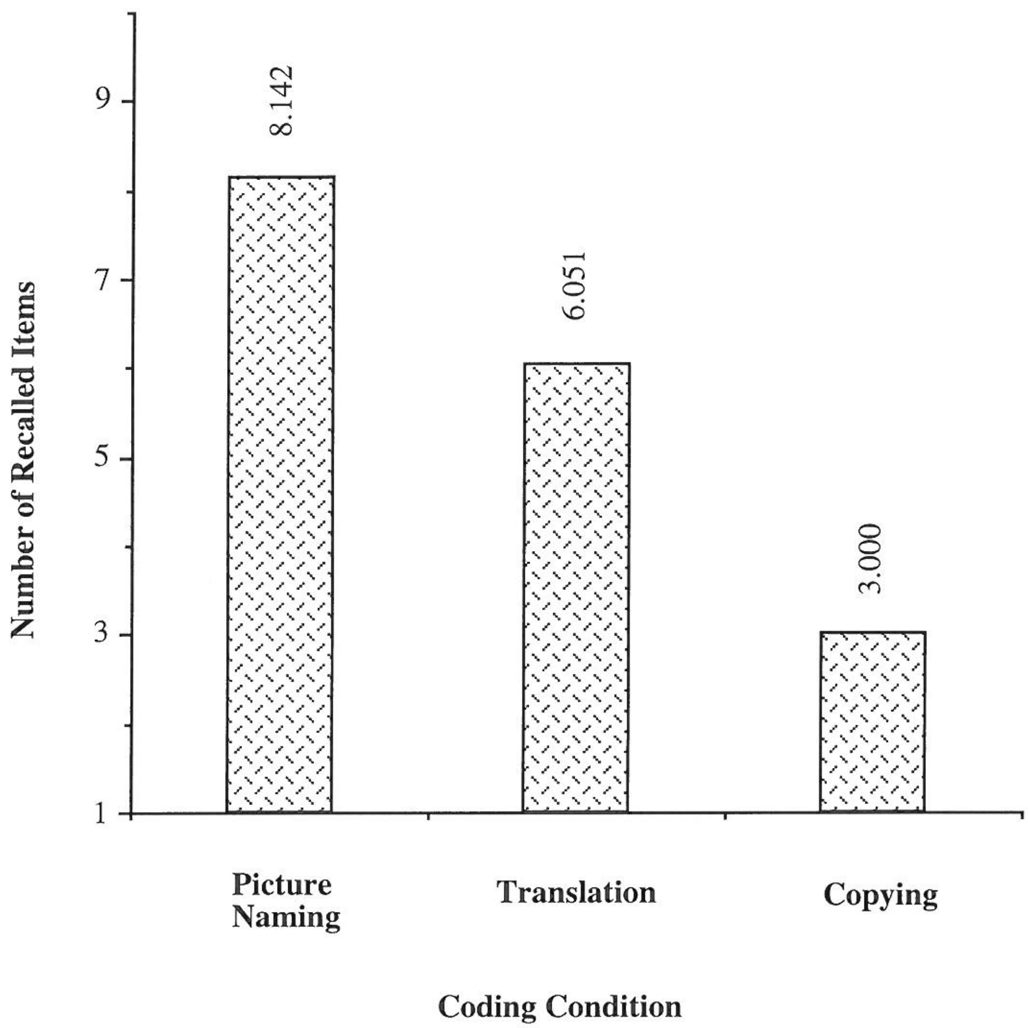
[Figure 5-2-11] Total Mean Difference in Number of Recalled Items
for the Three Spanish Proficiency Groups



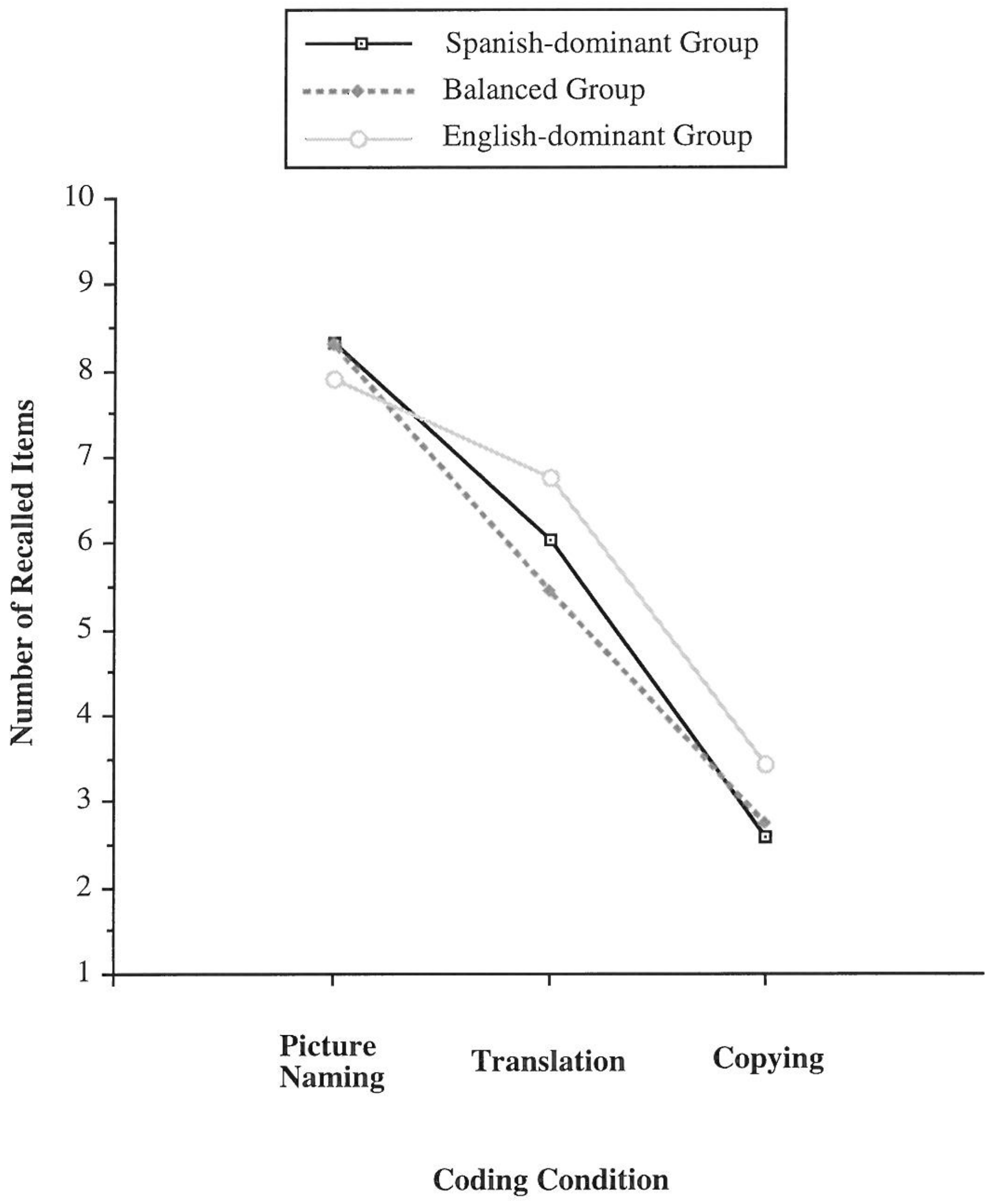
[Figure 5-2-12] Mean Difference in Number of Recalled Items for the Three Spanish Proficiency Groups by Recall Language



[Figure 5-2-13] Mean Difference in Number of Recalled Items by Coding Condition



[Figure 5-2-14] Mean Difference in Number of Recalled Items between Coding Conditions for Three Spanish Proficiency Groups



coding conditions for the English-dominant group was different from that of the other groups. Subjects in the English-dominant group recalled fewer number of items than the other groups in the Picture-Naming condition, while they recalled much more number of items than the other groups in the Translation and Copying conditions.

The mean difference in number of recalled items between the three coding conditions was now examined for each of the three proficiency groups (see also Figure 5-2-14). For the Spanish-dominant group, there was a significant difference in number of recalled items, $F\ (2, 46) = 34.456$, $p < .0001$. The mean number of recalled items in the Picture-Naming condition ($M = 8.33$) was significantly higher than that of the Translation condition ($M = 6.04$), $t\ (23) = 3.104$, $p = .005$, and the Copying condition ($M = 2.58$), $t\ (23) = 8.435$, $p < .0001$. The mean number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, $t\ (23) = 5.160$, $p < .0001$. For the Balanced group, a significant difference in number of recalled items was also found between the coding conditions, $F\ (2, 160) = 147.164$, $p < .0001$. The mean number of recalled items in the Picture-Naming condition ($M = 8.28$) was significantly higher than that of the Translation condition ($M = 5.44$), $t\ (80) = 8.683$, $p < .0001$, and the Copying condition ($M = 2.74$), $t\ (80) = 16.605$, $p < .0001$. The mean number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, $t\ (80) = 8.777$, $p < .0001$. For the English-dominant group, similar findings were again obtained. There was a significant difference in number of recalled items between the coding conditions, $F\ (2, 140) = 75.104$, $p < .0001$. The number of recalled items in the Picture-Naming condition ($M = 7.92$) was significantly higher than that of the Translation condition ($M = 6.75$), $t\ (70) = 2.857$, $p = .006$, and the Copying condition ($M = 3.44$), $t\ (70) = 12.684$, $p < .0001$. The number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, $t\ (70) = 8.875$, $p < .0001$.

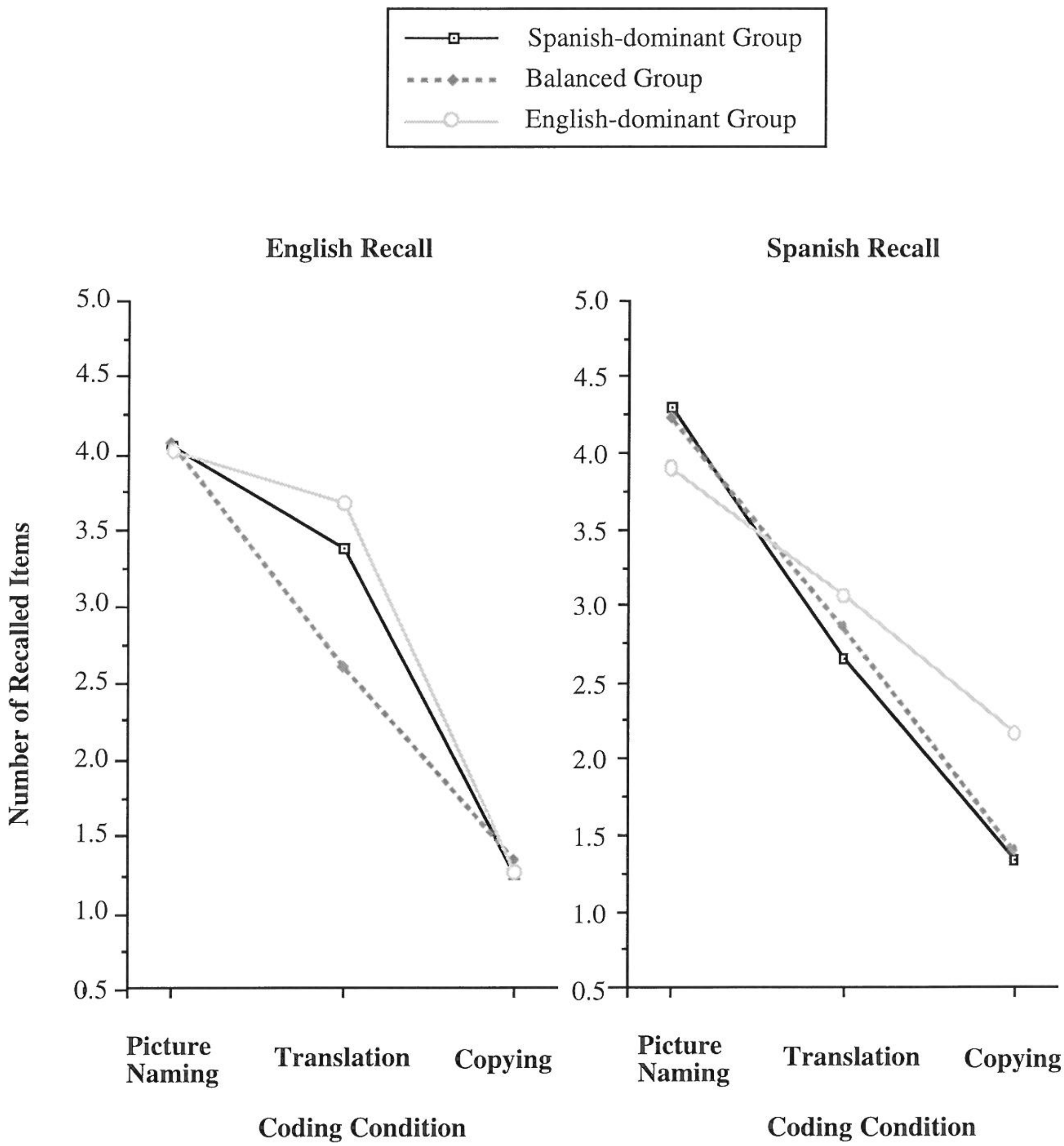
The mean difference in number of recalled items between the three proficiency groups was next examined by each coding condition (see Figure 5-2-14 again). In the Picture-Naming condition, there was no significant proficiency group difference in number of recalled items. However, in the Translation condition, a significant difference in number of recalled items was found, $F\ (2, 173) = 4.970$, $p = .008$. Tukey's HSD multiple comparisons showed that the only significant difference was found between the English-dominant and Balanced groups, $p = .005$. Subjects in the English-dominant group ($M = 5.44$) recalled significantly more items in the Translation condition than did subjects in the Balanced group ($M = 6.75$), $t\ (150) = 3.134$, $p = .002$. The Spanish-dominant group (M

= 6.04) also recalled more items than the Balanced group, but the difference was not statistically significant. In the Copying condition, there was a noticeable trend of difference in number of recalled items between the proficiency groups, although it was not statistically significant, $F(2, 173) = 2.777$, $p = .065$. Tukey's HSD multiple comparisons showed that the mean difference can be noticed between the English-dominant group ($M = 3.44$) and Balanced group ($M = 2.74$), although not significant, $p = .090$. In Figure 5-2-14, the mean number of recalled items for the Spanish-dominant group ($M = 2.58$) was actually lower than that of the Balanced group in the Copying condition, but the mean difference between the Spanish-dominant and English-dominant groups couldn't reach the significance because of the small number of subjects in the Spanish-dominant group ($n = 24$).

In order to see the mean difference in number of recalled items by all three variables: recall language, coding condition, and proficiency group, a three-way ANOVA was performed. The results showed that there was no significant between-group difference in number of recalled items for proficiency group as a main effect. There was neither significant difference in number of recalled items between the two recall languages, nor significant interaction between recall language and proficiency group. However, a significant difference in number of recalled items was found between the three coding conditions, $F(2, 346) = 192.989$, $p < .0001$. Moreover, a significant interaction was found between coding condition and proficiency group, $F(4, 346) = 3.099$, $p = .016$, between recall language and coding condition, $F(2, 346) = 4.796$, $p = .009$, and also between all three variables; recall language, coding condition, and proficiency group, $F(4, 346) = 4.683$, $p = .001$.

In English recall, no significant difference was found in number of recalled items between the proficiency groups but there was a significant difference between the coding conditions, $F(2, 346) = 130.990$, $p < .0001$. A significant interaction between coding condition and proficiency group was also found, $F(4, 346) = 4.286$, $p = .002$, (see Figure 5-2-15). A significant interaction effect was due to the significantly different numbers of recalled items in the Translation condition between the three proficiency groups, $F(2, 173) = 8.598$, $p < .0001$, while no proficiency group difference was found in the other two coding conditions. In the Translation condition, Tukey's HSD multiple comparisons showed that the difference in number of recalled items between the Balanced and English-dominant groups was significant, $p < .0001$, and the difference between the Balanced and Spanish-dominant groups was noticeable, $p = .099$. The mean number of recalled items for the Balanced group ($M = 2.59$) was significantly lower than that of the English-

[Figure 5-2-15] Mean Difference in Number of Recalled Items by Recall Language, Proficiency Group, and Coding Condition



dominant group (M = 3.68), t (150) = 4.106, $p < .0001$, and also lower, but not significantly, than that of the Spanish-dominant group (M = 3.38). However, no significant difference was noted between the Balanced and Spanish-dominant groups.

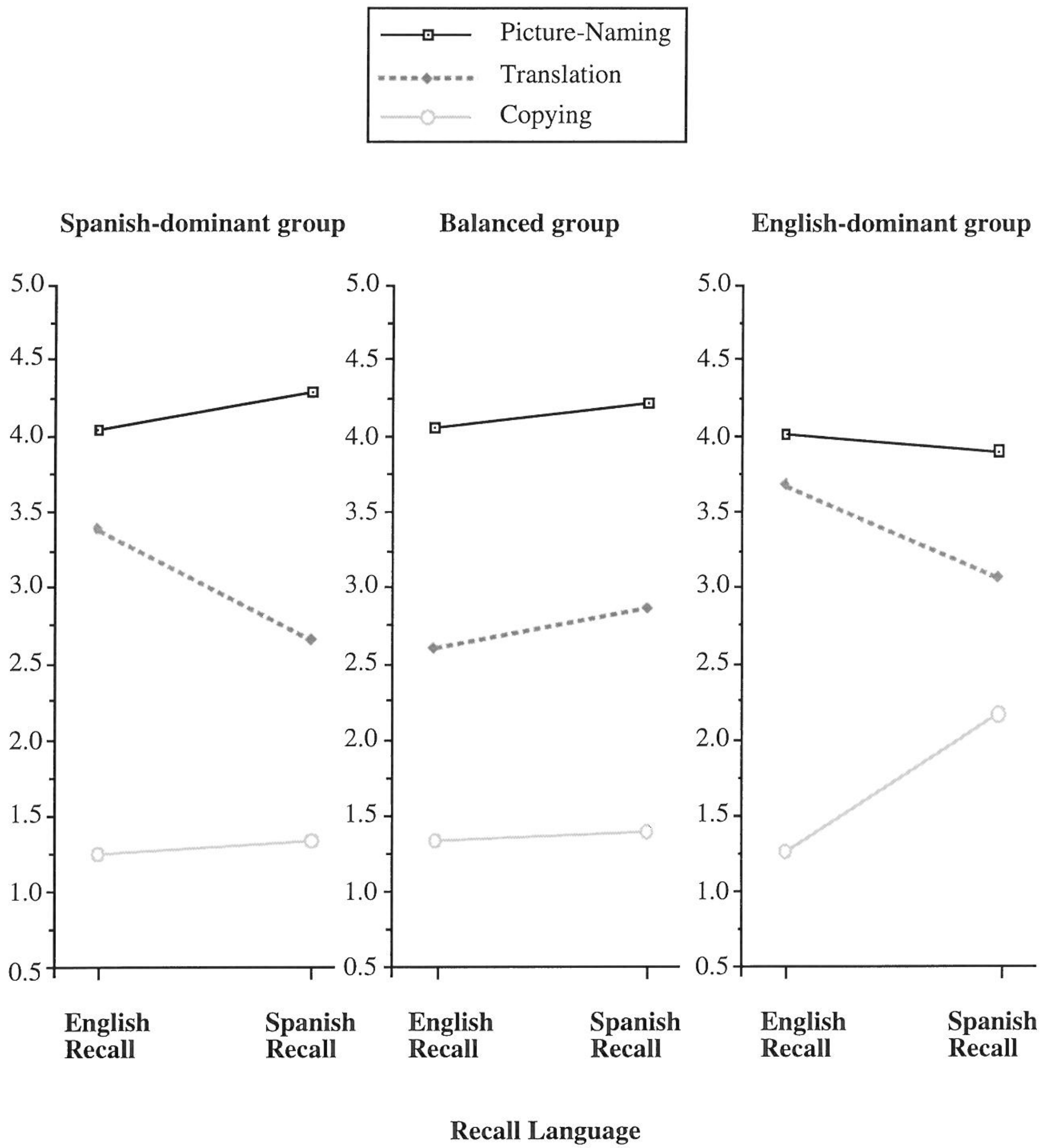
The mean difference between the three coding conditions in English recall was next examined for each of the three proficiency groups (see also Figure 5-2-15). For the Spanish-dominant group, there was a significant difference in number of recalled items between the coding conditions, F (2, 46) = 22.144, $p < .0001$. The mean number of recalled items in the Copying condition (M = 1.25) was significantly lower than that of the Picture-Naming condition (M = 4.04), t (23) = 6.627, $p < .0001$, and the Translation condition (M = 3.38), t (23) = 5.079, $p < .0001$, but no difference was found between the Picture-Naming and Translation conditions. For the Balanced group, there was also a significant difference in number of recalled items between the coding conditions, F (2, 160) = 76.966, $p < .0001$. The mean number of recalled items in the Picture-Naming condition (M = 4.06) was significantly higher than that of the Translation condition (M = 2.59), t (80) = 6.431, $p < .0001$, and the Copying condition (M = 1.35), t (80) = 11.919, $p < .0001$. The mean number of recalled items in the Translation condition was also significantly higher than that of the Copying condition, t (80) = 6.236, $p < .0001$. For the English-dominant group, a significant difference in number of recalled items was again found, F (2, 140) = 79.962, $p < .0001$. The mean number of the Copying condition (M = 1.27) was significantly lower than that of the Picture-Naming condition (M = 4.01), t (70) = 12.673, $p < .0001$, and the Translation condition (M = 3.68), t (70) = 10.671, $p < .0001$. No difference was found between the Translation and Copying conditions.

In Spanish recall, no significant difference was found in number of recalled items by proficiency group but there was a significant difference in number of recalled items by coding condition, F (2, 346) = 98.596, $p < .0001$. A significant interaction was also found between coding condition and proficiency group, F (4, 346) = 3.258, $p = .012$ (see Figure 5-2-15 again). A significant interaction effect was due to the significantly different numbers of recalled items in the Copying condition between the three proficiency groups, F (2, 173) = 6.544, $p = .002$, while no proficiency group difference was found in the other two coding conditions. In the Copying condition, the mean number of recalled items for the English-dominant group (M = 2.17) was significantly higher than that of the Spanish-dominant group (M = 1.33), t (93) = 2.348, $p = .021$, and the Balanced group (M = 1.395), t (150) = 3.315, $p < .0001$. No proficiency group difference in number of recalled items attained statistical significance in the Picture-Naming and Translation conditions.

The mean difference between the three coding conditions in Spanish recall was also examined for each of the three proficiency groups (see also Figure 5-2-15). For the Spanish-dominant group, there was a significant difference in number of recalled items between the coding conditions, F (2, 46) = 28.407, $p < .0001$. The mean number of recalled items in the Picture-Naming condition (M = 4.29) was significantly higher than that of the Translation condition (M = 2.67), t (23) = 3.825, $p < .0001$, and the Copying condition (M = 1.33), t (23) = 7.822, $p < .0001$. There was also a significant difference between the Translation and Copying conditions, t (23) = 3.562, $p = .002$. For the Balanced group, there was a significant difference in number of recalled items between the coding conditions, F (2, 160) = 88.255, $p < .0001$. The mean number of recalled items in the Picture-Naming condition (M = 4.22) was significantly higher than that of the Translation condition (M = 2.85), t (80) = 7.135, $p < .0001$, and the Copying condition (M = 1.395), t (80) = 19.252, $p < .0001$. There was also a significant difference between the Translation and Copying conditions, t (80) = 24.604, $p < .0001$. Similar findings were obtained for the English-dominant group. There was a significant difference in number of recalled items between the coding conditions, F (2, 140) = 21.357, $p < .0001$. The mean number of recalled items in the Picture-Naming condition (M = 3.90) was significantly higher than that of the Translation condition (M = 3.07), t (70) = 3.132, $p = .003$ and the Copying condition (M = 2.17), t (70) = 6.567, $p < .0001$. A significant difference was also found between the Translation and Copying conditions, t (70) = 3.386, $p = .001$.

The mean difference in number of recalled items between the two languages was now examined by coding condition for each of the three proficiency groups (see Figure 5-2-16). For the Spanish-dominant group, no significant difference in number of recalled items between English and Spanish recalls was found in any of the coding conditions. However, the difference between the two language recalls was noticeable, although not significant, in the Translation condition, t (23) = 1.764, $p = .091$, with Spanish-dominant subjects having higher recall in English than in Spanish. There was no significant difference in number of recalled items between the two language recalls for the Balanced group in all three coding conditions. For the English-dominant group, however, a different pattern of significant results was found. The mean number of recalled items in Spanish (M = 2.17) was significantly higher than in English (M = 1.27) in the Copying condition, t (70) = 4.206, $p < .0001$, whereas the Spanish recall (M = 3.07) was significantly lower than the English recall (M = 3.68) in the Translation condition, t (70) = 2.292, $p = .025$. No significant mean difference was found between the two language recalls in the Picture-Naming condition. As can be seen in Figure 5-2-16, the pattern of

[Figure 5-2-16] Difference in Number of Recalled Items between Two Language Recalls by Coding Condition in Three Spanish Proficiency Groups



significant difference in number of recalled items was opposite for the Spanish-dominant and English-dominant groups: more recall in English for the Spanish-dominant group and more recall in Spanish for the English-dominant group. However, the Balanced group did not show any significant difference in number of recalled items between the two language recalls. For the Spanish-English bilingual group, there was no significant gender difference found in number of recalled items.

Comparisons of Korean-English and Spanish-English bilingual data. There was no significant between-group difference in number of recalled items by bilingual language group: between the Korean-English or Spanish-English bilingual groups. However, a significant interaction was found between bilingual language group and coding condition, $F(2, 668) = 7.413$, $p = .001$. A test for mean difference effect showed that a significant difference between the bilingual language groups was found in the Translation and Copying conditions, (compare Figure 5-2-5 and Figure 5-2-15). The mean number of recalled items in the Translation condition for the Korean-English bilingual group ($M = 7.10$) was significantly higher than that of the Spanish-English bilingual group ($M = 6.05$). However, an opposite pattern of significant difference was found in the Copying condition. The mean number of recalled items in the Copying condition for the Korean-English bilingual group ($M = 2.52$) was significantly lower than that of the Spanish-English bilingual group ($M = 3.00$). No difference was noted in the Picture-Naming condition.

More specifically, a significant interaction between bilingual language group and coding condition was examined by each language recall. In English recall, a significant difference in number of recalled items was noted only in the Translation condition, $F(1, 334) = 8.106$, $p = .005$. The mean number of recalled items in the Translation condition for the Korean-English bilingual group ($M = 3.85$) was significantly higher than that of the Spanish-English bilingual group ($M = 3.14$). However, no significant difference was found in the Picture-Naming and Copying conditions. In another language recall (Korean or Spanish), a significant difference in number of recalled items was found in the Copying condition, $F(1, 334) = 7.574$, $p = .006$. The mean number of recalled items in the Copying condition for the Spanish-English bilingual group ($M = 1.70$) was significantly higher than that of the Korean-English bilingual group ($M = 1.18$). Moreover, in another language recall, the mean difference in number of recalled items in the Translation condition was also noticeable, although not significant, $F(1, 334) = 3.318$, $p = .069$. The mean number of recalled items in the Translation condition for the Korean-English bilingual

group (M = 3.26) was noticeably higher than that of the Spanish-English bilingual group (M = 2.92).

Results of Task 3 (Recognition of presenting mode).

In Task 3, subjects were asked to indicate the mode of each item presented in Task 1. During Task 1, stimulus items were presented to subjects either in pictures, in English words, or in Korean/Spanish words. The number of items whose presenting mode was correctly recognized was analyzed based on the subject's proficiency assignment (English-dominant, Balanced, and Korean/Spanish-dominant groups), coding condition (Picture-Naming, Translation, and Copying conditions), and coding language (English or Korean/Spanish). Recognition data for each of the two bilingual groups (Korean-English and Spanish-English bilingual groups) was first analyzed separately, then between-group comparisons were performed. Analysis of Task 3 showed that subjects correctly recognized the presenting mode of items more when the stimuli were presented in a picture form and named, and the least when they were simply copied during Task 1. When stimulus items were translated, the number of items whose presenting mode was correctly recognized was related to the subject's proficiency level in the language used in Task 1. For example, unbalanced bilingual subjects recognized the presenting mode of items significantly better when the items were presented in their weaker language than when they were presented in the dominant language. A detailed discussions of the analysis and results of Task 3 is provided in Appendix 8.

Discussion

Subjects in this study recalled the items in the Picture-Naming and Translation conditions significantly better than those in the Copying condition (see Figure 5-2-4 and Figure 5-2-14). This pattern of recall was consistently found regardless of the subject's bilinguality; that is, the proficiency level in the two languages of the bilingual subject. This was also true regardless of the language combinations (Korean-English and Spanish-English), which means that linguistic similarity or dissimilarity did not alter the pattern of recall. This finding supports the bilingual dual coding hypothesis (Paivio, 1990; Paivio & Desrochers, 1980), which claims that *verbal-nonverbal* or *bilingual* coding has an additive effect on recall.

The recall pattern found in this study with *balanced* bilinguals provided the same outcomes reported by previous studies (i.e., Paivio & Lambert, 1981; Arnedt & Gentile, 1986; Vaid, 1988). However, the recall pattern of *unbalanced* bilinguals in this study resulted in different outcomes. First, in the case of balanced bilinguals, the number of recalled items in the Picture-Naming condition was significantly higher than that of the Translation condition, which was, in turn, significantly higher than that of the Copying condition (see Figure 5-2-5 and Figure 5-2-15). This order of recall was exactly the same as that reported in previous studies which were also conducted using balanced bilinguals. The insight gained from this dissertation was that the order of recall between the three coding conditions was the same regardless of the similarities or differences between a bilingual's two languages (Korean-English and Spanish-English). This finding demonstrated the invariance of the recall order regardless of the language combinations found in bilingual subjects. Thus, this finding answered the initial question of whether different patterns of memory recall would emerge depending on the languages spoken by the bilingual.

Unlike the case of the balanced bilinguals, different recall patterns were found for *unbalanced* bilinguals. When I first designed this study, I expected that subjects would recall more items which required translation into the weaker language than items translated into the stronger language. However, a part of the findings from this study did not support my hypothesis while other parts of the results did support my hypothesis. For example, Korean-dominant and Spanish-dominant unbalanced bilinguals confirmed the recall pattern that I expected. However, English-dominant unbalanced bilinguals provided the opposite pattern of findings to my expectation. First of all, both Korean-dominant and Spanish-dominant unbalanced bilingual subjects, as can be seen in Figure 5-2-5 and Figure 5-2-15, recalled as many Translated items as Picture-Named items, when asked to translate items into English, their weaker language. Therefore, there was no significant difference in number of recalled items between the Picture-Naming and Translation conditions for these unbalanced bilinguals, when stimulus items were coded and recalled in their weaker language, English. This finding was the same as I expected. However, when stimulus items were translated from English into Korean or Spanish, a significant difference in number of recalled items was again obtained between the Picture-Naming and Translation conditions, and the recall pattern was the same as that of the balanced bilinguals.

On the other hand, in the case of English-dominant unbalanced bilinguals in both the Korean and Spanish language groups, the opposite results were found from the case of Korean-dominant or Spanish-dominant unbalanced bilinguals. That is, the English-

dominant unbalanced bilinguals, as can also be seen in Figures 5-2-5 and 5-2-15, recalled as many stimulus items which were translated into English, their stronger language, as items which were Picture-Named. Therefore, there was no significant difference in number of recalled items between the Picture-Naming and Translation conditions. However, when stimulus items were translated into Korean or Spanish which was the weaker language of the subjects, there was a significant difference in number of recalled items between the Picture-Naming and Translation conditions. This finding contradicted my initial expectation which was that stimulus items would be recalled more when they were coded in the subject's weaker language. English-dominant unbalanced bilinguals in this study recalled more items when they were asked to translate items into their stronger language than those translated into their weaker language. How can these findings be interpreted?

If the findings are examined without consideration of my initial expectation regarding more recall in the weaker language, we would notice that *unbalanced* bilingual subjects, both English-dominant and Korean (or Spanish)-dominant bilinguals, recalled as many items in the Translation condition as those in the Picture-Naming condition when subjects coded and recalled stimulus items *in English.* The recall pattern for unbalanced bilinguals when they coded and recalled in Korean or Spanish was the same as that of the balanced bilinguals who recalled significantly more Picture-Named items than Translated items. In order to explain my findings, I need to consider two different aspects: first, general principles working in bilingual memory and second, specific characteristics of the bilingual subjects who participated in the present study.

First of all, it is necessary to introduce the main principles that are working in bilingual memory recall. The first principle acknowledges the "Dual Coding Theory" (Paivio, 1990; Paivio & Desrochers, 1980). Dual coding theory explains how it is that verbal-nonverbal and bilingual codings produce an additive effect on recall. Thus, stimulus items in the Picture Naming and Translation conditions are recalled more than copied items. The second principle is that of "Imagery Superiority". This principle addresses the issue of *level of processing* (Bradshaw & Anderson, 1982; Craik & Lockhart, 1972; Craik & Tulving, 1975) in bilingual memory. It is generally conceded that verbal-nonverbal processing (which is imagery processing) requires a deeper and more elaborate processing mechanism than does processing information between two language systems. The principle of Imagery Superiority can be explained by the revised version of the bilingual dual coding model proposed by Hammer & Blanc (1989). In their revised bilingual dual coding model, Hammer & Blanc (1989) suggested that the two verbal systems in bilinguals

shared a common semantic memory device and they were related to each other more closely than they were to the imagery system. According to the revised bilingual dual coding model, the processing of information between the verbal and imagery systems (i.e., picture naming) requires a deeper level of processing than between the two verbal systems (i.e., translation). Therefore, stimulus items in the Picture Naming condition are recalled more than those in the Translation condition because more processing effort is required to encode them in long term memory.

In order to interpret the findings in this study with *unbalanced* bilinguals, one additional principle is needed. The third principle is that of "Weaker Language Prominence". This principle states that subjects remember more items when they must process them in their weaker language, because using the weaker language requires more effort which heightens the salience of items in memory. This principle includes a level of processing provision which is totally dependent on whether individual's dominant or weaker language is involved in memory storage or retrieval.

As we apply the principle of "Weaker Language Prominence" in the case of the unbalanced bilingual subject's *translation* process, it should be noted that memory recall "from the dominant language to the weaker language" process (DL ->WL) is harder than "from the weaker language to the dominant language" process (WL -> DL). Searching for a translation equivalent word in the unbalanced bilingual's weaker language for a given word in the dominant language requires more effort and a deeper level of processing than does searching for a translation equivalent word in the dominant language when the word was initially provided in the weaker language. This is due to the fact that processing information in a productive way (e.g., searching for a word) requires more effort than does processing information receptively (e.g., understanding a given word). In applying the third principle with the other two principles, it is assumed that processing information from the dominant language to the weaker language (DL -> WL) has the same effect on recall as Imagery Superiority.

In addition to general principles, it is also important to consider certain characteristics of the bilingual subjects employed in the present study. For example, the English-dominant unbalanced bilingual subjects in this study possessed a lower proficiency in the other language (Korean or Spanish), while Korean (or Spanish)-dominant unbalanced bilinguals possessed more English proficiency although they also were definitely unbalanced. This most likely occurred because my subjects were recruited in an English-speaking country and also because the subjects were mostly highly educated

university students. Even though they were either Korean-dominant or Spanish-dominant, their proficiency in English was high enough for them to function in a university environment. The different levels of language proficiency of each bilingual group is presented in Appendix 6 and visually depicted in Figure A6-1. As the three principles are applied in bilingual memory processing, it needs to be noted that the bilingual's proficiency in each language should exceed *a certain threshold level.* For example, the Weaker Language Prominence principle may not work in exactly the same as I explained it for unbalanced bilinguals whose weaker language falls under a minimum threshold proficiency level which may be the case with the English-dominant group in this study.

Armed with the three principles and also with consideration of the proficiency level of each language of the subjects used in this study, the findings can now be examined. First of all, in the case of the balanced bilinguals only, the first two principles applied in their recall memory processing but the Weaker Language Prominence principle was not necessary because the two languages were both dominant in these balanced bilinguals. Thus, the Dual Coding Theory principle operated, and stimulus items in the Picture Naming (PN) and Translation (TR) conditions were recalled significantly more than those in the Copying (CP) condition: PN, TR > CP. Secondly, the Imagery Superiority principle was applicable and stimulus items in the Picture Naming condition were recalled significantly more that those in the Translation condition: PN > TR. With these first two principles, balanced bilingual subjects recalled more items in the Picture Naming condition then Translated items, and lastly Copied items: PN > TR > CP. Further, there was no need to speculate about a language combination group difference between Korean-English and Spanish-English bilinguals since there were no between-group differences in memory recall (see Figure 5-2-5 and Figure 5-2-15).

For unbalanced bilinguals whose weaker language's proficiency was *above* a certain threshold level such as in the case of the Korean-dominant or Spanish-dominant unbalanced bilinguals in this study, the principles were applied as follows. First, the Dual Coding Theory principle was applied and stimulus items in the Picture Naming and Translation conditions were recalled significantly more than those in the Copying condition: PN, TR > CP. Second, the Imagery Superiority principle and Weaker Language Prominence principle were applied together depending on the direction of the translation process. If subjects were asked to code stimulus items in their weaker language, the translation process was from the dominant language to the weaker language (DL -> WL) which required as much effort in processing information as did the process between the verbal and imagery systems. In this case, the Weaker Language Prominence principle

evened out the Imagery Superiority principle and there was no significant difference in number of recalled items between the Picture-Naming and Translation conditions: PN = TR. Thus, Korean-dominant and Spanish-dominant unbalanced bilinguals in the present study, when asked to code items in English (their weaker language), recalled as many Translated items as Picture-Named items which were significantly more than Copied items: PN = TR > CP (see the English Recall graph in both Figure 5-2-5 and Figure 5-2-15).

On the other hand, if subjects were asked to code stimulus items in their dominant language, the act of translating from the weaker language to the dominant language (WL -> DL) required less effort in processing than did the transfer between the verbal and imagery systems. In this case, the Imagery Superiority principle won over the Weaker Language Prominence principle and there appeared a significant difference in number of recalled items between the Picture-Naming and Translation conditions: PN > TR. Thus, Korean-dominant and Spanish-dominant unbalanced bilinguals in this study, when asked to code items in their dominant language (Korean or Spanish), recalled significantly more items in the Picture Naming condition than in the Translation condition which, in turn, were significantly more than recalled items in the Copying condition: PN > TR > CP (see the Korean Recall graph in Figure 5-2-5 and the Spanish Recall graph in Figure 5-2-15).

Turning now to the case of unbalanced bilinguals whose proficiency in the weaker language was *below* a certain threshold level, such as in the case of the English-dominant unbalanced bilinguals in this study, it was presumed that the operating principles were not applied in the same way as they were with unbalanced bilinguals whose proficiency in the weaker language was *above* the threshold. The Dual Coding Theory principle, however, was applied first, as always, and stimulus items in the Picture Naming and Translation conditions were recalled significantly more than those in the Copying condition: PN, TR > CP. Secondly, the Imagery Superiority principle and Weaker Language Prominence principle were applied together, but this depended on which language (dominant or weaker) subjects used, not on the direction of the translation process. The assumption was that the direction of translation (either DL -> WL or WL -> DL) did not influence the level of processing in bilinguals if the subject's weaker language was below a certain level of proficiency. For example, if subjects were asked to code and recall items in a weaker language for which they had a very low level of proficiency, all three processes including Picture-Naming, Translation, and even Copying required considerable effort to complete. In this case, the Imagery Superiority principle was more salient than the Weaker Language Prominence principle and subjects recalled significantly more items in the Picture-Naming condition that those of the Translation condition: PN > TR. Thus, English-dominant

unbalanced bilinguals in this study, when asked to code items in Korean or Spanish (their weaker language), recalled significantly more items in the Picture-Naming condition than they did in the Translation condition. Then, items in the Copying condition were recalled the least: PN > TR > CP (see the Korean Recall graph in Figure 5-2-5 and the Spanish Recall graph in Figure 5-2-15).

On the other hand, if these subjects were asked to code stimulus items in their dominant language, the translation process required them to use their weaker language in which they had very low proficiency. In this case, the Weaker Language Prominence principle evened out the Imagery Superiority principle and there was no significant difference in number of recalled items between the Picture-Naming and Translation conditions: PN = TR. Thus, English-dominant unbalanced bilinguals in this study, when asked to code items in their dominant language (English), recalled as many Translated items as Picture-Named items because the act of translating required subjects to use a language in which they were not very proficient. Items in both the Picture-Naming and Translation conditions were recalled significantly more than those of the Copying condition as predicted by the Dual Coding Theory principle: PN = TR > CP (see the English Recall graph in both Figure 5-2-5 and Figure 5-2-15).

The significant contribution of this dissertation is that it offers a systematic examination of bilingual memory representation with different language combinations and with bilinguals whose degree of proficiency in the two languages varies. The findings of this research confirm the validity of the Dual Coding Theory in bilingual memory (Paivio, 1990; Paivio & Desrochers, 1980). However, we needed to introduce a *level of processing* approach (Bradshaw & Anderson, 1982; Craik & Lockhart, 1972; Craik & Tulving, 1975) to explain the more salient recall for Picture-Named items than Translated items. Hamers & Blanc's (1989) revised version of the bilingual dual coding model was also recognized necessary to account for the better recall of items in the Picture-Naming condition than that of the Translation condition. A level of processing approach was especially important in explaining the findings obtained from the unbalanced bilinguals. Since unbalanced bilinguals have not been used previously in memory research, the findings reported here clearly suggest that we need studies that examine the full continuum of bilingual proficiency, to better understand how bilinguals process information in two languages.

Another important finding in this study was that bilingual memory representation was similar in the two very different bilingual language combination groups. The coding,

recall, and recognition patterns between the Korean-English and Spanish-English bilingual groups were strikingly the same. It was interesting to find the same results from both the Korean-English and Spanish-English bilingual groups because I had expected possible differences in memory processing between the two bilingual groups. My expectation was based on the fact that Korean and English differ so much in their morphological, syntactic, semantic, and orthographic features, whereas Spanish and English share many of these linguistic features. Since the findings appear to be so uniform across the two different bilingual groups, this can be taken as additional support for the three operating principles (Dual Coding Theory, Imagery Superiority, and Weaker Language Prominence) postulated to be responsible for the order of recall between the Picture-Naming, Translation, and Copying conditions.

Finally, it is also very important to note that unbalanced bilinguals processed information differently depending upon whether proficiency in their weaker language attained a certain threshold level. Again, this outcome demonstrates the importance of understanding how *all* bilinguals process information in their two languages not just those who have achieved balance in their languages. This recommendation is especially important, I believe, since in reality few bilinguals actually attain *equal* and *high* proficiency in two languages even though on a superficial level they appear to function adequately in their two linguistic worlds.

APPENDIX 1

List of 180 Words in Three Languages (English, Spanish, and Korean) and Their Pictorial Representations (180 Pictures) Used in the Stimulus Item Selection Study (Study II)

I.D.: identification number for each item

E: Word: Word in English

S: Word: Word in Spanish

K: Word: Word in Korean

[Appendix 1] List of 180 Words used in Stimulus Item Selection Study in 3 Languages

I.D.	E: Word	S: Word	K: Word	I.D.	E: Word	S: Word	K: Word
1	airplane	avion	비행기	35	button	boton	단추
2	alligator	caiman	악어	36	cake	pastel	케이크
3	anchor	ancla	닻	37	camel	camello	낙타
4	angel	angel	천사	38	camera	camara	사진기
5	ant	hormiga	개미	39	candle	vela	양초
6	apple	manzana	사과	40	candy	dulce	사탕
7	arm	brazo	팔	41	cane	baston	지팡이
8	arrow	flecha	화살	42	car	carro	자동차
9	ashtray	cenicero	재털이	43	cat	gato	고양이
10	baby	bebe	아기	44	chain	cadena	사슬
11	ball	pelota	공	45	chair	silla	의자
12	balloon	globo	풍선	46	cherry	cereza	앵두
13	bat	garrote	방망이	47	chicken	pollo	닭
14	basket	canasta	바구니	48	chimney	chimenea	굴뚝
15	bear	oso	곰	49	church	iglesia	교회
16	bed	cama	침대	50	cigar	puro	궐련
17	bee	abeja	벌	51	cigarette	cigarro	담배
18	bell	campana	종	52	circle	circulo	동그라미
19	belt	cinturon	벨트	53	clock	reloj	시계
20	bicycle	bicicleta	자전거	54	closet	gabinete	옷장
21	bird	pajaro	새	55	cloud	nube	구름
22	boat	bote	돛단배	56	clown	payaso	광대
23	book	libro	책	57	coat	saco	코우트
24	boot	bota	부츠	58	comb	peine	머리빗
25	bottle	botella	유리병	59	cord	cordon	노끈
26	bow	mono	리본	60	corn	maiz	옥수수
27	bowl	tazon	대접	61	cow	vaca	소
28	box	caja	상자	62	crown	corona	왕관
29	bread	pan	빵	63	cup	copa	커피잔
30	broom	escoba	빗자루	64	deer	venado	사슴
31	brush	cepillo	솔	65	desk	escritorio	책상
32	bulb	foco	전구	66	dog	perro	개
33	bus	autobus	버스	67	donkey	burro	당나귀
34	butterfly	mariposa	나비	68	door	puerta	문

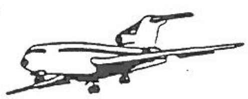
[Appendix 1] List of 180 Words used in Stimulus Item Selection Study in 3 Languages

I.D.	E: Word	S: Word	K: Word	I.D.	E: Word	S: Word	K: Word
69	dragonfly	caballito	잠자리	103	house	casa	집
70	drum	tambor	북	104	iron	plancha	다리미
71	duck	pato	오리	105	kettle	caldera	주전자
72	eagle	aguila	독수리	106	key	llave	열쇄
73	ear	oreja	귀	107	kite	cometa	연
74	earth	la tierra	지구	108	knife	cuchillo	칼
75	elephant	elefante	코끼리	109	ladder	escalera	사다리
76	envelope	sobre	봉투	110	lamp	lampara	램프
77	eye	ojo	눈	111	leaf	hoja	잎사귀
78	feather	pluma	깃털	112	leg	pierna	다리
79	finger	dedo	손가락	113	lion	leon	사자
80	fish	pescado	물고기	114	lips	labios	입술
81	flag	bandera	깃발	115	map	mapa	지도
82	flower	flor	꽃	116	monkey	mono	원숭이
83	foot	pie	발	117	moon	luna	달
84	fork	penedor	포오크	118	mountan	montana	산
85	fountain	fuente	분수	119	mouse	raton	쥐
86	fox	zorro	여우	120	mushroom	hongo	버섯
87	frog	sapo	개구리	121	nail	clavo	못
88	giraffe	jirafa	기린	122	necklace	collar	목걸이
89	glass	vidrio	유리컵	123	necktie	corbata	넥타이
90	glasses	anteojos	안경	124	needle	aguja	바늘
91	glove	guante	장갑	125	newspaper	periodico	신문
92	goat	chivo	염소	126	nose	nariz	코
93	grapes	uvas	포도	127	onion	cebolla	양파
94	grasshopper	saltamontes	메뚜기	128	ostrich	avestruz	타조
95	hair	pelo	머리카락	129	owl	tecolote	올빼미
96	hammer	martillo	망치	130	pants	pantalon	바지
97	hand	mano	손	131	peacock	pavoreal	공작
98	hanger	gancho	옷걸이	132	pencil	lapiz	연필
99	harp	arpa	하아프	133	piano	piano	피아노
100	hat	sombrero	모자	134	pig	cerdo	돼지
101	helicopter	helicoptero	헬리콥터	135	pistol	pistola	권총
102	horse	caballo	말	136	purse	bolsa	지갑

[Appendix 1] List of 180 Words used in Stimulus Item Selection Study in 3 Languages

I.D.	E: Word	S: Word	K: Word	I.D.	E: Word	S: Word	K: Word
137	rabbit	conejo	토끼	171	turkey	pavo	칠면조
138	refrigerator	refrigerador	냉장고	172	turtle	tortuga	거북이
139	ring	anillo	반지	173	umbrella	paraguas	우산
140	roof	techo	지붕	174	violin	violin	바이올린
141	rose	rosa	장미	175	watch	reloj	손목시계
142	ruler	regla	자	176	watermelon	sandia	수박
143	scissors	tijeras	가위	177	wheel	rueda	바퀴
144	sheep	lampara	양	178	window	ventana	창문
145	shoe	zapato	신발	179	zebra	cebra	얼룩말
146	slide	resbaladilla	미끄럼틀	180	zipper	cierre	지퍼
147	snail	caracol	달팽이				
148	snake	culebra	뱀				
149	sneaker	tenis	운동화				
150	snowman	muneco de nieve	눈사람				
151	sock	calcetin	양말				
152	soldier	soldado	군인				
153	spider	arana	거미				
154	spoon	cuchara	숟가락				
155	stamp	estampilla	우표				
156	star	estrella	별				
157	strawberry	fresa	딸기				
158	sun	sol	해				
159	swan	cisne	백조				
160	swing	resbaladilla	그네				
161	table	mesa	탁자				
162	tail	cola	꼬리				
163	telephone	telefono	전화				
164	tiger	tigre	호랑이				
165	toothbrush	cepillo de dientes	칫솔				
166	tower	torre	탑				
167	train	tren	기차				
168	tree	arbol	나무				
169	triangle	triangulo	삼각형				
170	truck	camion	트럭				

[Appendix 1] List of 180 Pictures used in Stimulus Item Selection Study

1. 

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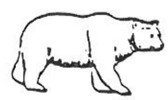
15. 

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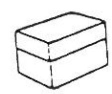
28. 

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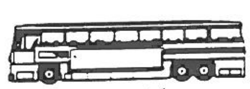
33. 

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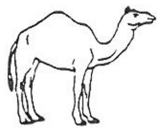
[Appendix 1] List of 180 Pictures used in Stimulus Item Selection Study

37. 

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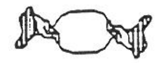
40. 

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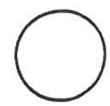
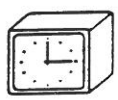
52. 

53. 

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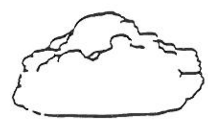
55. 

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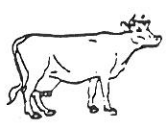
61. 

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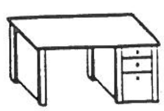
65. 

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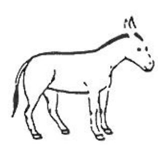
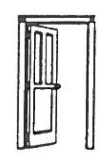
67. 

68. 

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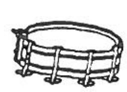
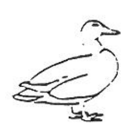
70. 

71. 

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[Appendix 1] List of 180 Pictures used in Stimulus Item Selection Study

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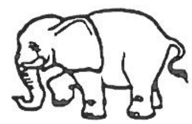
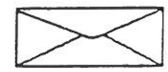
75. 

76. 

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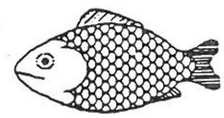
80. 

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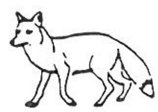
86. 

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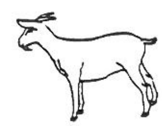
92. 

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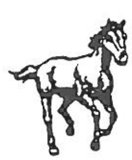
102. 

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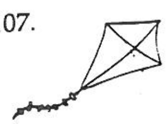
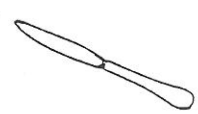
107. 

108. 

[Appendix 1] List of 180 Pictures used in Stimulus Item Selection Study

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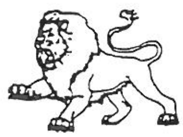
113. 
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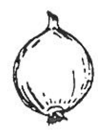
127. 
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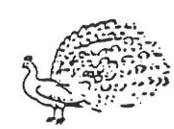
131. 
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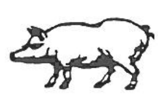
134. 
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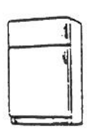
138. 
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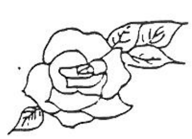
141. 
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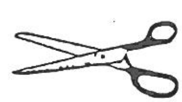
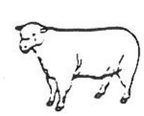
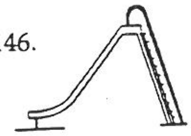
143. 
144. 

[Appendix 1] List of 180 Pictures used in Stimulus Item Selection Study

145. 

146. 

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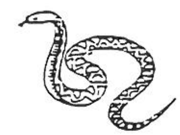
148. 

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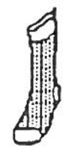
151. 

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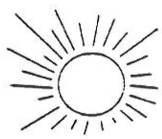
158. 

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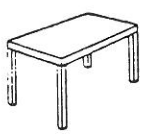
161. 

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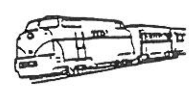
167. 

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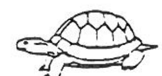
172. 

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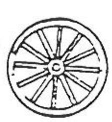
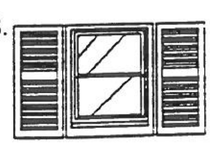
177. 

178. 

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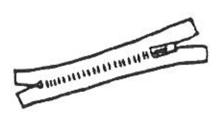
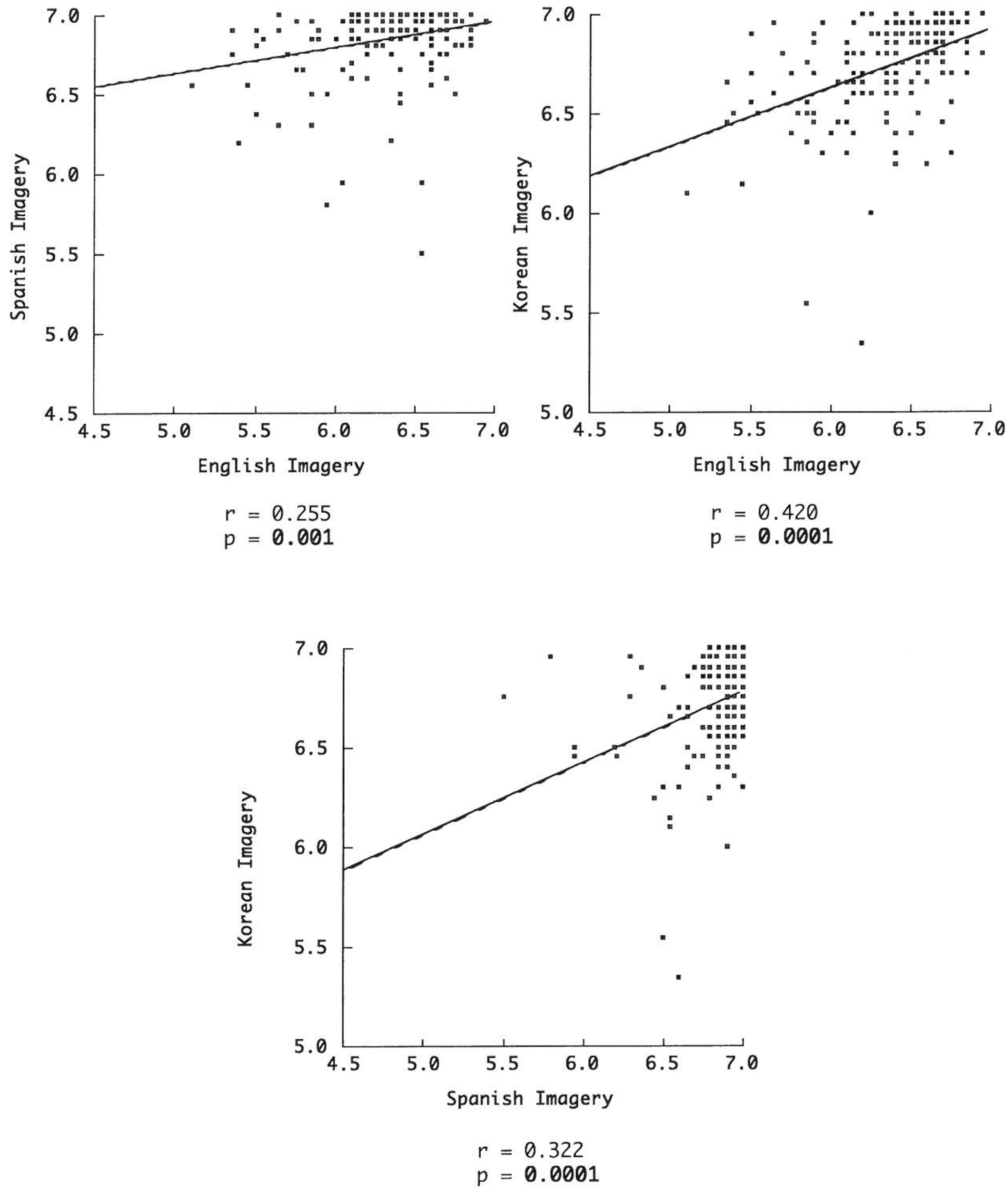
180. 

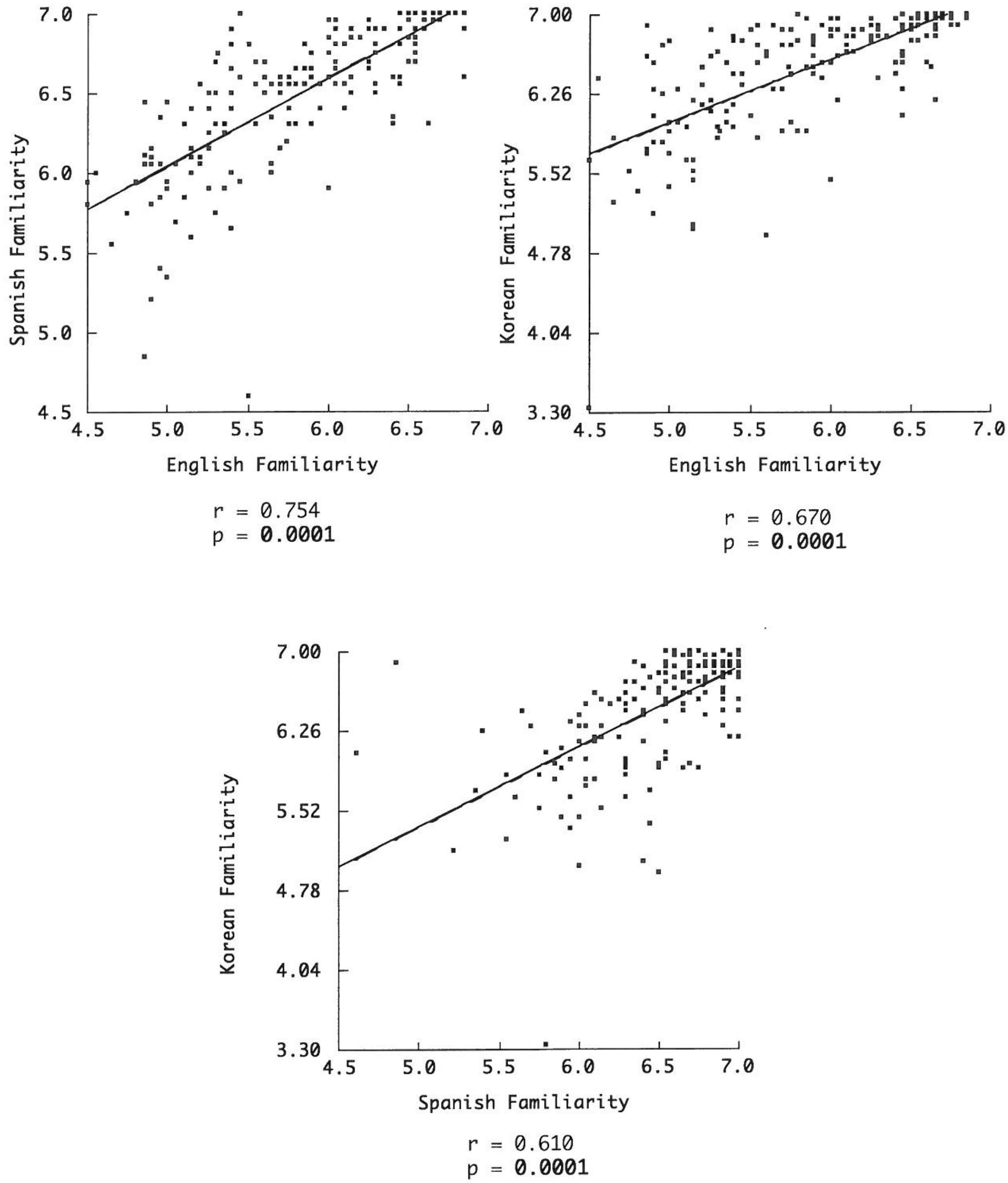
APPENDIX 2

Relationships of Ratings between the Three Languages and Three Tasks in the Stimulus Item Selection Study (Study II)

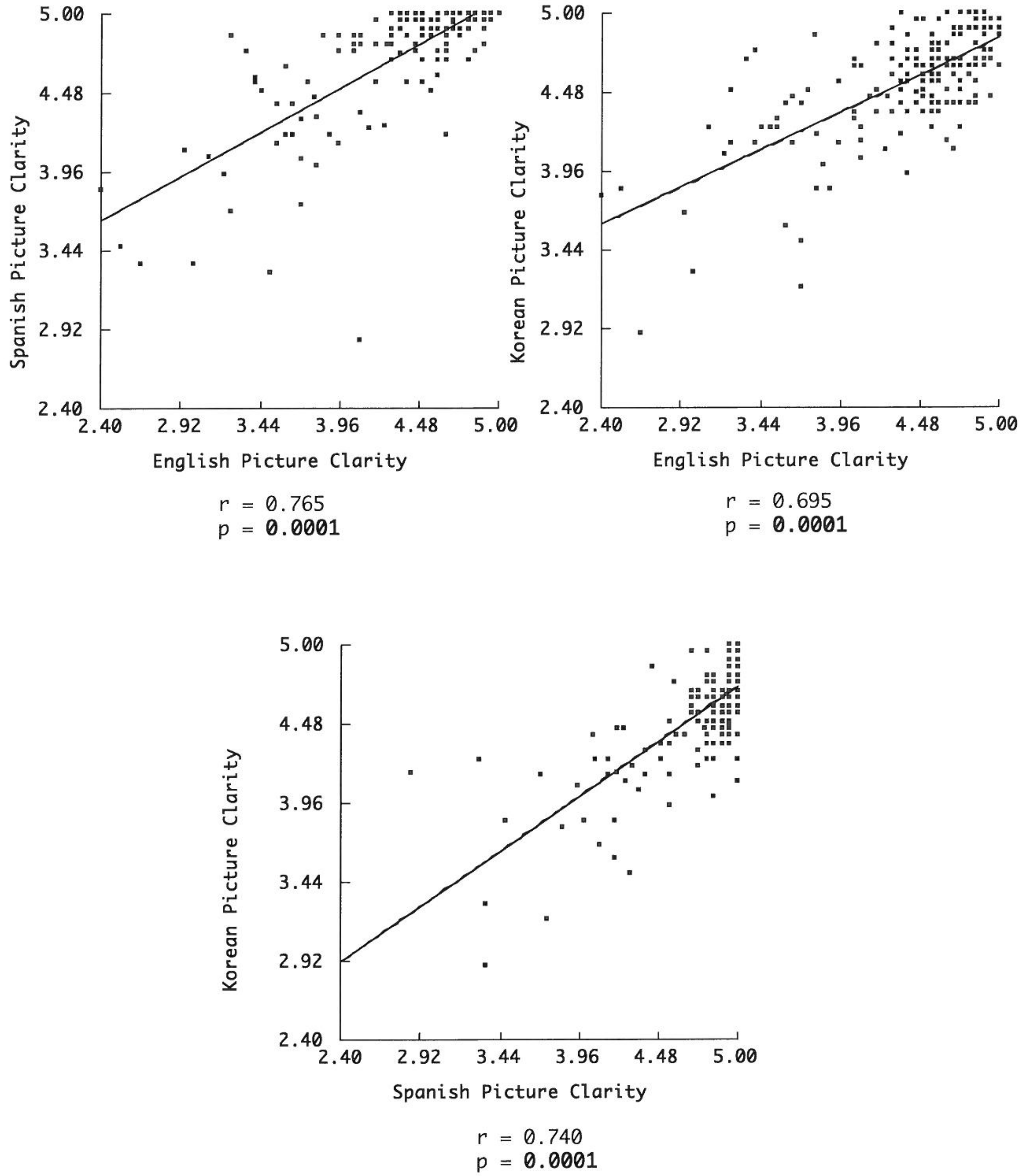
[Figure A2-1] Relationships between the Three Languages in Imagery Task



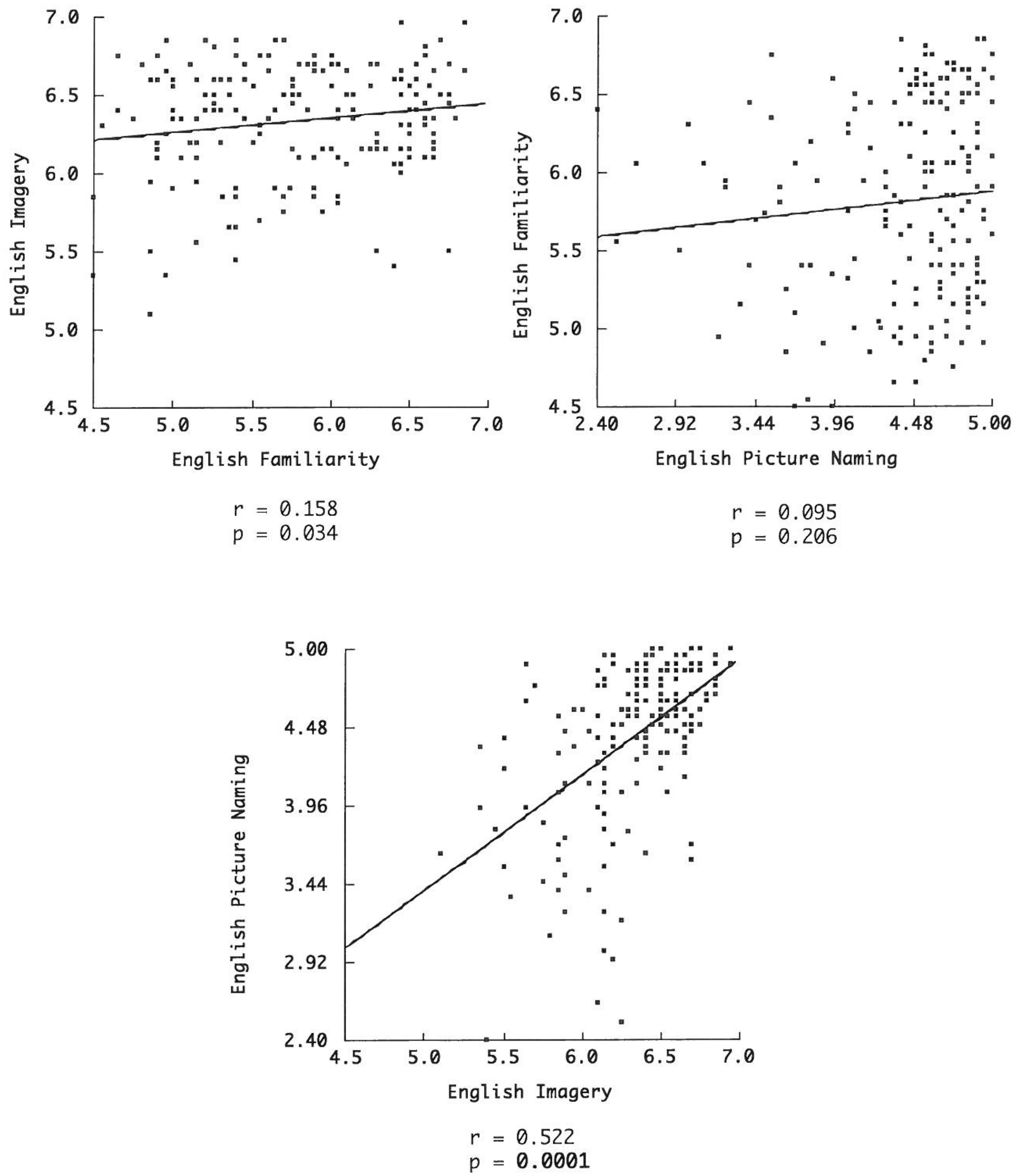
[Figure A2-2] Relationships between the Three Languages in Familiarity Task



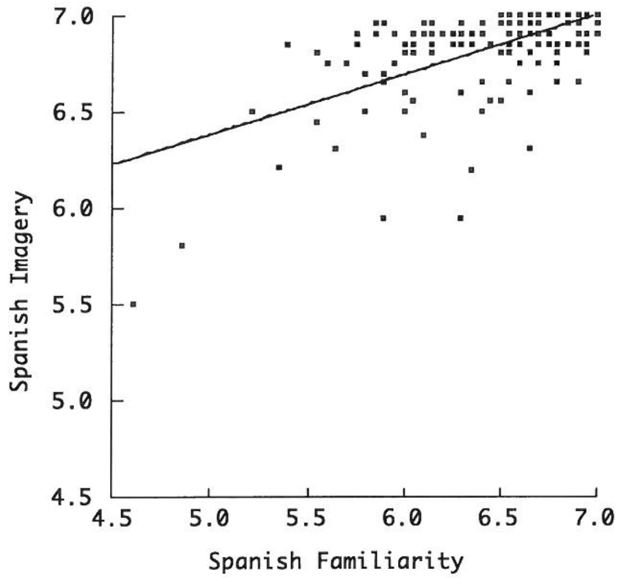
[Figure A2-3] Relationships between the Three Languages in Picture Clarity Task



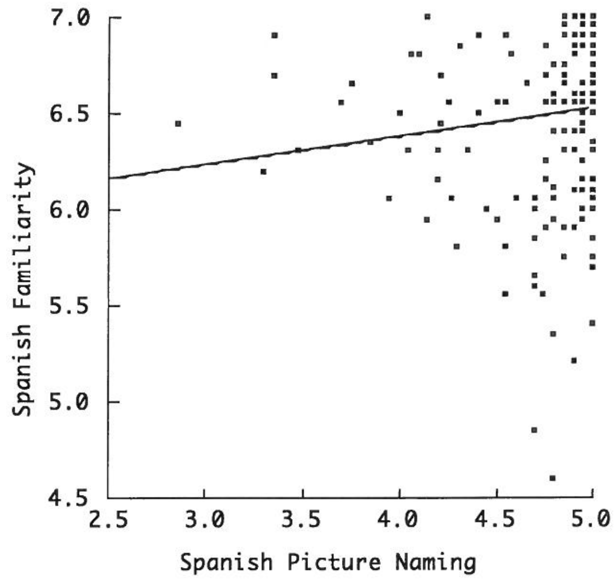
[Figure A2-4] Relationships between the Three Tasks in English Ratings



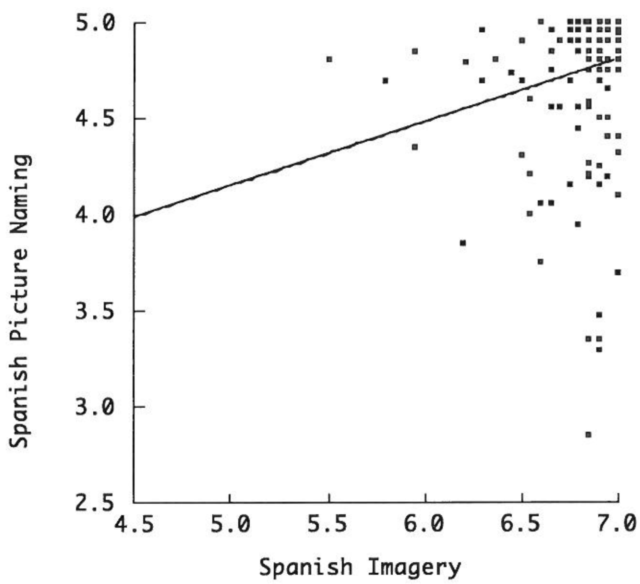
[Figure A2-5] Relationships between the Three Tasks in Spanish Ratings



r = 0.610
p = **0.0001**

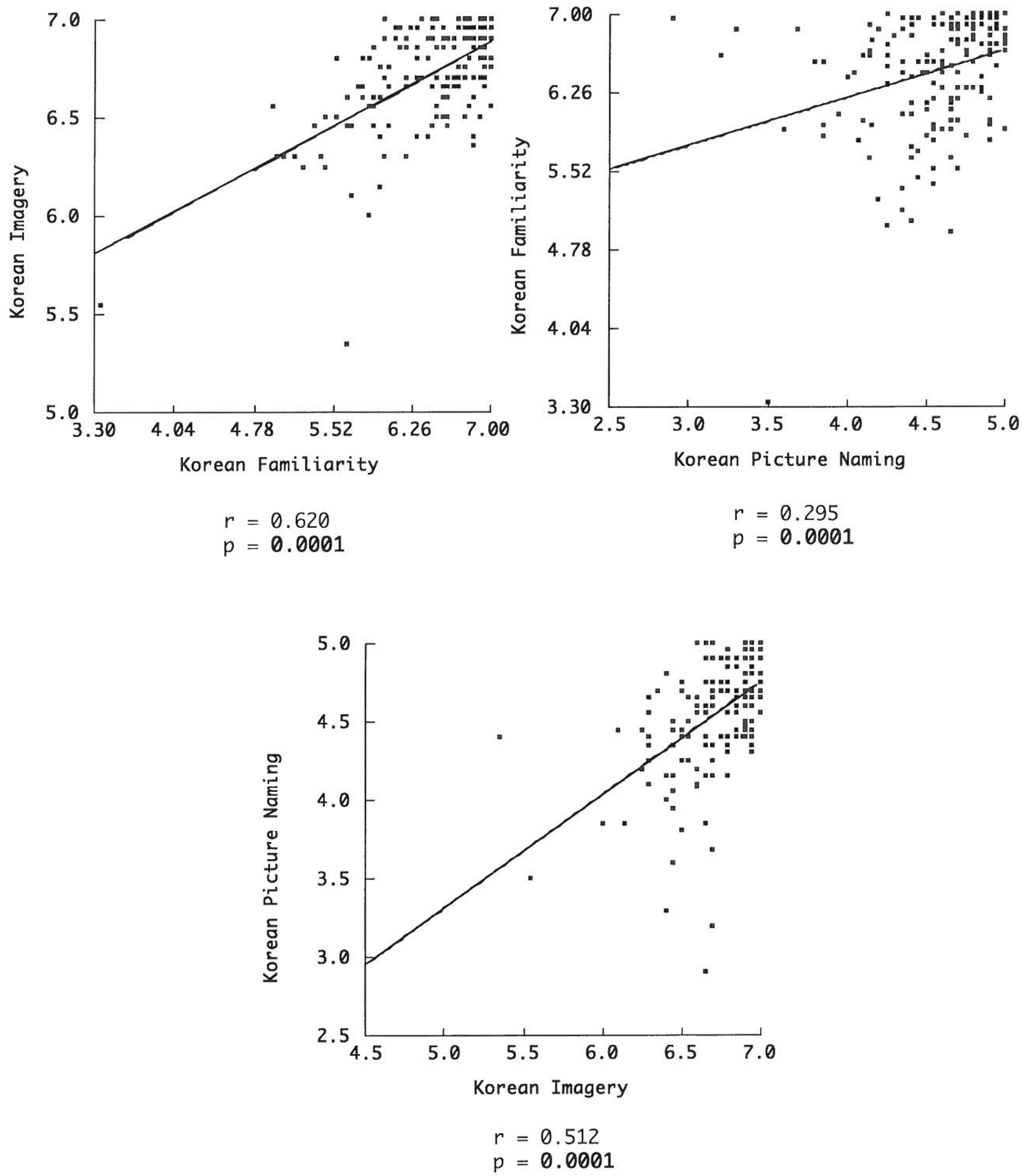


r = 0.123
p = 0.100



r = 0.197
p = **0.008**

[Figure A2-6] Relationships between the Three Tasks in Korean Ratings



APPENDIX 3

Rating Data for Each Item in the Stimulus Item Selection Study (Study II)

Sorted by "Picture Clarity" Mean Rating Scores

I.D.: identification number for each item

EI: Imagery rating scores in English
SI: Imagery rating scores in Spanish
KI: Imagery rating scores in Korean
Iav: Average mean scores for Imagery rating

EF: Familiarity rating scores in English
SF: Familiarity rating scores in Spanish
KF: Familiarity rating scores in Korean
Fav: Average mean scores for Familiarity rating

EN: Picture Clarity rating scores in English
SN: Picture Clarity rating scores in Spanish
KN: Picture Clarity rating scores in Korean
Nav: Average mean scores for Picture Clarity rating

E#: Number of different names given to each item in English
S#: Number of different names given to each item in Spanish
K#: Number of different names given to each item in Korean
#T: Total number of different names given to each item

[Appendix 3] Rating Data Sorted by Picture Clarity Mean Ratings

	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ
1	I.D.	Word	EI	SI	KI	Iav	EF	SF	KF	Fav	EN	SN	KN	Nav	E#	S#	K#	#T
2	96	hammer	6.7	6.9	7	6.867	5.9	6.75	6.7	6.45	5	5	4.95	4.983				0
3	106	key	6.45	7	6.95	6.8	6.6	7	7	6.867	5	5	4.95	4.983				0
4	20	bicycle	6.95	6.95	7	6.967	6.45	6.9	7	6.783	5	5	4.9	4.967	10	1		11
5	83	foot	6.4	7	6.9	6.767	6.55	6.75	7	6.767	4.9	5	5	4.967				0
6	163	telephone	6.7	7	6.95	6.883	6.75	7	6.95	6.9	5	5	4.9	4.967				0
7	42	car	6.65	6.75	6.95	6.783	6.85	6.6	7	6.817	4.95	5	4.95	4.967		7		7
8	18	bell	6.5	6.9	6.95	6.783	5.8	6.65	6.75	6.4	4.85	5	5	4.95				0
9	45	chair	6.55	7	6.95	6.833	6.5	7	6.95	6.817	4.9	5	4.95	4.95			1	1
10	97	hand	6.65	7	7	6.883	6.65	7	7	6.883	4.85	5	5	4.95				0
11	104	iron	5.65	7	6.95	6.533	5.4	6.65	6.8	6.283	4.9	4.95	5	4.95				0
12	135	pistol	6.2	6.9	6.65	6.583	4.9	6.1	5.8	5.6	4.95	5	4.9	4.95	16		1	17
13	143	scissors	6.5	7	6.95	6.817	6.1	6.8	6.7	6.533	5	5	4.85	4.95				0
14	84	fork	6.3	7	6.9	6.733	6.6	7	6.95	6.85	4.85	5	4.95	4.933				0
15	90	glasses	6.35	7	6.9	6.75	6.15	6.85	6.8	6.6	4.9	5	4.9	4.933		13	1	14
16	98	hanger	6.2	6.8	7	6.667	6.3	6.5	6.8	6.533	4.9	5	4.9	4.933	1	3		4
17	123	necktie	6.4	7	6.85	6.75	5.3	6.5	6.65	6.15	4.95	4.95	4.9	4.933	18			18
18	133	piano	6.6	6.95	6.95	6.833	5.25	6.4	6.85	6.167	4.85	4.95	5	4.933	1		2	3
19	156	star	6.35	7	6.85	6.733	6.15	6.6	6.85	6.533	4.9	5	4.9	4.933		1	1	2
20	170	truck	6.4	7	6.7	6.7	6.15	6.5	6.65	6.433	4.8	5	5	4.933		7	1	8
21	175	watch	6.15	7	6.8	6.65	6.65	7	6.8	6.817	4.95	4.95	4.9	4.933	1	1		2
22	81	flag	6.4	6.95	6.6	6.65	5.85	6.65	5.9	6.133	4.75	5	5	4.917		1	16	17
23	172	turtle	6.7	6.95	6.75	6.8	5.1	5.85	5.95	5.633	4.85	5	4.9	4.917	2			2
24	173	umbrella	6.75	7	6.95	6.9	5.55	6.7	6.7	6.317	4.85	5	4.9	4.917	1	8		9
25	16	bed	6.95	6.95	6.8	6.9	6.85	7	6.95	6.933	4.9	4.95	4.85	4.9	1			1
26	58	comb	6.5	7	6.9	6.8	6.45	6.8	6.6	6.617	4.8	5	4.9	4.9		2	2	4
27	63	cup	6.4	6.95	6.7	6.683	6.5	6.7	6.85	6.683	4.8	5	4.9	4.9	1	19	3	23
28	116	monkey	6.5	6.85	6.85	6.733	5.25	6.25	6.2	5.9	4.85	4.95	4.9	4.9		5		5
29	101	helicopter	6.85	6.8	6.7	6.783	5.7	6.15	6.3	6.05	4.95	5	4.75	4.9			2	2
30	53	clock	6.5	7	6.95	6.817	6.7	6.95	6.95	6.867	4.75	5	4.9	4.883		2	1	3
31	56	clown	6.75	6.95	6.55	6.75	5.6	6.5	4.95	5.683	5	5	4.65	4.883		1	3	4

[Appendix 3] Rating Data Sorted by Picture Clarity Mean Ratings

	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ
32	65	desk	6.35	6.95	6.95	6.75	6.6	6.9	7	6.833	4.65	5	5	4.883				0
33	119	mouse	6.5	6.85	7	6.783	5.35	6.3	6	5.883	4.75	5	4.9	4.883		2		2
34	148	snake	6.6	6.9	6.8	6.767	5.3	5.75	5.85	5.633	4.9	5	4.75	4.883		11		11
35	33	bus	6.4	7	7	6.8	6.05	6.65	6.95	6.55	4.85	5	4.8	4.883		9	1	10
36	75	elephant	6.85	6.9	7	6.917	5.2	6.05	6.5	5.917	4.9	4.8	4.95	4.883				0
37	80	fish	6.65	7	6.95	6.867	6.1	6.55	6.8	6.483	4.85	5	4.8	4.883		10	2	12
38	169	triangle	6.45	6.9	6.75	6.7	5.75	6.3	6.7	6.25	4.95	5	4.7	4.867			1	1
39	6	apple	6.85	7	7	6.95	6.7	7	7	6.9	4.7	5	4.9	4.867				0
40	100	hat	6.4	6.85	6.85	6.7	5.65	6.35	6.9	6.3	4.75	5	4.85	4.867			1	1
41	102	horse	6.85	6.9	6.8	6.85	5.65	6.05	6.3	6	4.75	5	4.85	4.867	1			1
42	1	airplane	6.8	6.8	6.95	6.85	6.6	6.95	6.8	6.783	4.7	4.95	4.9	4.85	11	1		12
43	34	butterfly	6.7	6.95	7	6.883	5.45	6.6	6.75	6.267	4.9	5	4.65	4.85			3	3
44	61	cow	6.75	7	7	6.917	5.9	6.65	6.45	6.333	4.9	4.95	4.7	4.85			1	1
45	73	ear	6.55	7	6.95	6.833	6.25	6.65	6.95	6.617	4.9	5	4.65	4.85		7		7
46	88	giraffe	6.85	6.842	6.95	6.881	4.95	5.4	6.25	5.533	4.7	5	4.85	4.85		1		1
47	126	nose	6.3	7	6.8	6.7	6.5	6.95	6.95	6.8	4.7	4.947	4.9	4.849				0
48	37	camel	6.55	6.75	6.9	6.733	5	5.95	6	5.65	4.85	4.95	4.7	4.833		2		2
49	147	snail	6.35	6.9	6.7	6.65	5.15	6.1	6.2	5.817	4.85	4.95	4.7	4.833		1		1
50	107	kite	6.6	6.7	6.9	6.733	5.35	5.9	6.1	5.783	4.9	4.9	4.65	4.817		14		14
51	154	spoon	6.25	7	6.9	6.717	6.65	6.95	6.85	6.817	4.5	5	4.95	4.817			5	5
52	31	brush	6	6.85	6.4	6.417	6.45	6.9	6.3	6.55	4.6	5	4.8	4.8	1	1	4	6
53	36	cake	6.4	6.9	6.7	6.667	6.05	6.55	6.85	6.483	4.75	5	4.65	4.8		2		2
54	87	frog	6.35	6.75	6.85	6.65	5.05	5.7	6.3	5.683	4.7	5	4.7	4.8	1	11	1	13
55	145	shoe	6.35	7	6.9	6.75	6.65	6.95	6.9	6.833	4.8	5	4.6	4.8			3	3
56	161	table	6.1	7	6.3	6.467	6.65	7	6.2	6.617	4.75	5	4.65	4.8			2	2
57	103	house	6.4	7	6.8	6.733	6.55	7	7	6.85	4.45	4.95	4.95	4.783			2	2
58	125	newspaper	6.15	6.95	6.7	6.6	6.25	6.9	6.75	6.633	4.75	4.9	4.7	4.783	2	1	1	4
59	137	rabbit	6.4	7	7	6.8	5.2	6.55	6.35	6.033	4.85	4.95	4.55	4.783				0
60	167	train	6.3	6.9	6.9	6.7	5.55	6.55	6.55	6.217	4.6	4.95	4.8	4.783		1	1	2
61	171	turkey	6.6	6.8	6.25	6.55	5.15	6	5.45	5.533	4.95	4.95	4.45	4.783		7		7
62	10	baby	6.7	6.9	6.8	6.8	6.25	6.95	6.9	6.7	4.55	4.95	4.85	4.783		6		6

[Appendix 3] Rating Data Sorted by Picture Clarity Mean Ratings

	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ
63	11	ball	6.75	7	6.7	6.817	6	6.95	6.95	6.633	4.6	5	4.75	4.783	3	1	3	7
64	14	basket	6.15	6.85	6.7	6.567	5.75	6.55	6	6.1	4.8	4.9	4.65	4.783		2	2	4
65	26	bow	5.35	6.9	6.65	6.3	4.947	6.35	6.7	5.999	4.35	5	5	4.783	1	5		6
66	7	arm	6.45	7	6.95	6.8	6.75	7	7	6.917	4.55	4.95	4.8	4.767			1	1
67	24	boot	6.5	6.95	6.6	6.683	5.7	6.5	5.9	6.033	4.7	5	4.6	4.767	1		7	8
68	79	finger	6.25	7	7	6.75	6.5	7	6.9	6.8	4.6	5	4.7	4.767				0
69	132	pencil	6.6	7	6.9	6.833	6.45	6.9	6.9	6.75	4.65	4.85	4.8	4.767				0
70	165	toothbrush	6.5	7	7	6.833	6.75	7	6.9	6.883	4.6	4.95	4.75	4.767	2	9		11
71	12	balloon	6.7	6.75	6.85	6.767	5.85	6.8	6.95	6.533	4.7	4.9	4.65	4.75		3		3
72	23	book	6.65	7	6.95	6.867	6.85	6.9	7	6.917	4.4	5	4.85	4.75				0
73	76	envelope	5.85	6.3	6.75	6.3	6.05	6.65	6.95	6.55	4.55	4.95	4.75	4.75			2	2
74	77	eye	6.6	7	6.75	6.783	6.55	6.9	6.75	6.733	4.6	4.95	4.7	4.75			1	1
75	93	grapes	6.7	7	6.95	6.883	6	6.6	6.95	6.517	4.85	4.95	4.45	4.75		2		2
76	105	kettle	5.95	5.8	6.95	6.233	4.85	4.85	6.9	5.533	4.6	4.7	4.95	4.75	5	16		21
77	120	mushroom	6.6	6.85	6.9	6.783	5.75	6.6	6.85	6.4	4.65	4.9	4.7	4.75		1		1
78	155	stamp	6.1	6.85	6.85	6.6	6.5	6.85	6.9	6.75	4.85	4.75	4.65	4.75		6		6
79	30	broom	6.75	6.95	6.895	6.865	6	6.85	6.8	6.55	4.85	4.95	4.4	4.733				0
80	117	moon	6.55	7	6.9	6.817	6	6.6	6.85	6.483	4.3	5	4.9	4.733	1		7	8
81	134	pig	6.5	6.95	6.85	6.767	5.2	6.1	6.15	5.817	4.65	4.9	4.65	4.733		12	1	13
82	8	arrow	6.4	6.9	6.95	6.75	5.4	6.4	6.15	5.983	4.75	4.9	4.5	4.717		1	15	16
83	15	bear	6.75	6.8	6.9	6.817	5.4	6.65	6.45	6.167	4.6	4.95	4.6	4.717	3	1	1	5
84	32	bulb	5.7	6.75	6.8	6.417	5.55	6.7	6.9	6.383	4.75	5	4.4	4.717	10	5	1	16
85	38	camera	6.65	6.9	6.9	6.817	5.6	6.6	6.65	6.283	4.6	4.95	4.6	4.717		2		2
86	108	knife	6.5	7	6.85	6.783	6.45	7	6.85	6.767	4.55	4.95	4.65	4.717			2	2
87	113	lion	6.85	6.85	6.85	6.85	5.4	6	6.15	5.85	4.8	4.95	4.4	4.717			1	1
88	99	harp	6.35	6.85	6.8	6.667	4.75	5.75	5.55	5.35	4.75	4.85	4.55	4.717		1		1
89	110	lamp	6.35	6.85	6.65	6.617	6.05	6.95	6.2	6.4	4.6	5	4.55	4.717			5	5
90	130	pants	6.3	6.95	6.8	6.683	6.45	6.6	7	6.683	4.55	4.9	4.7	4.717	1		1	2
91	158	sun	6.55	7	6.85	6.8	6.5	7	6.9	6.8	4.45	5	4.7	4.717			2	2
92	49	church	6.1	6.95	6.75	6.6	5.8	6.55	7	6.45	4.4	5	4.7	4.7	1	2		3
93	71	duck	6.45	6.9	6.9	6.75	5.25	6.15	6.2	5.867	4.5	4.95	4.65	4.7				0

[Appendix 3] Rating Data Sorted by Picture Clarity Mean Ratings

	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ
94	150	snowman	6.6	6.9	6.95	6.817	4.9	6.05	6.3	5.75	4.8	4.7	4.6	4.7		11		11
95	13	bat	5.65	6.3	6.95	6.3	5.4	5.65	6.45	5.833	4.65	4.7	4.7	4.683	1	20	7	28
96	174	violin	6.55	6.95	6.85	6.783	6.63	6.3	6.5	6.477	4.55	4.9	4.6	4.683	1	2	1	4
97	3	anchor	6.1	6.6	6.3	6.333	5.15	6	5	5.383	4.75	5	4.25	4.667			1	1
98	21	bird	6.6	6.8	6.85	6.75	6.55	6.8	6.9	6.75	4.55	4.9	4.55	4.667		1	4	5
99	52	circle	6.05	6.95	6.65	6.55	6.1	6.4	6.65	6.383	4.45	4.8	4.75	4.667		1	3	4
100	60	corn	6.35	6.9	6.9	6.717	5.6	6.7	6.6	6.3	4.4	4.85	4.75	4.667	1	8		9
101	82	flower	6.6	7	6.95	6.85	6.4	6.6	6.95	6.65	4.7	4.9	4.4	4.667	1	2	2	5
102	180	zipper	6.4	6.65	6.7	6.583	5.85	6.55	6.5	6.3	4.35	4.95	4.65	4.65		5		5
103	19	belt	6.5	6.9	6.4	6.6	6.15	6.9	6.85	6.633	4.2	4.95	4.8	4.65		6	8	14
104	114	lips	6.7	7	6.95	6.883	6.55	6.7	7	6.75	4.5	4.85	4.6	4.65		7		7
105	67	donkey	6.4	6.85	6.3	6.517	5	6.45	5.4	5.617	4.4	4.95	4.55	4.633	2	1	2	5
106	164	tiger	6.8	6.95	6.95	6.9	5.25	5.9	6.1	5.75	4.65	4.75	4.5	4.633		4		4
107	72	eagle	6.6	6.65	6.85	6.7	5	5.9	5.9	5.6	4.6	4.75	4.55	4.633		2		2
108	136	purse	5.85	6.95	6.35	6.383	5.7	6.6	6.85	6.383	4.3	4.9	4.7	4.633	1	7	11	19
109	141	rose	6.65	7	6.9	6.85	5.9	6.6	6.75	6.417	4.3	4.8	4.8	4.633	2	1		3
110	109	ladder	6.6	6.9	6.9	6.8	5.45	7	6.45	6.3	4.45	4.95	4.474	4.625				0
111	168	tree	6.5	7	6.9	6.8	6.55	6.85	6.95	6.783	4.5	4.9	4.45	4.617	1	12	3	16
112	2	alligator	6.55	5.5	6.75	6.267	5.5	4.6	6.05	5.383	4.65	4.8	4.4	4.617		4	2	6
113	22	boat	6.55	5.95	6.5	6.333	6	5.9	5.45	5.783	4.55	4.85	4.45	4.617	10	18	7	35
114	29	bread	6.35	6.95	6.5	6.6	6.8	7	6.9	6.9	4.55	4.9	4.4	4.617	1	1		2
115	47	chicken	6.7	7	6.9	6.867	6.3	6.8	6.4	6.5	4.45	5	4.4	4.617	6	14	1	21
116	89	glass	5.5	6.8	6.7	6.333	6.3	6.55	6.9	6.583	4.4	4.85	4.6	4.617			3	3
117	92	goat	6.2	6.75	6.6	6.517	5.15	5.6	5.65	5.467	4.5	4.7	4.65	4.617		11		11
118	129	owl	6.75	6.5	6.3	6.517	4.9	5.211	5.15	5.087	4.6	4.9	4.35	4.617		15	6	21
119	149	sneaker	5.9	6.9	6.85	6.55	5.65	6.55	6.9	6.367	4.45	4.75	4.65	4.617	7	7	1	15
120	51	cigarette	6.2	6.95	6.6	6.583	5.3	6.3	5.95	5.85	4.35	4.9	4.55	4.6			1	1
121	66	dog	6.65	7	6.95	6.867	6.45	6.9	6.55	6.633	4.35	4.95	4.5	4.6			6	6
122	43	cat	6.75	7	6.95	6.9	6.6	7	6.55	6.717	4.5	4.95	4.35	4.6	5	1		6
123	111	leaf	6.35	6.85	6.6	6.6	6.05	6.9	6.6	6.517	4.7	5	4.1	4.6		1		1
124	25	bottle	6.15	7	6.65	6.6	6	6.75	6.55	6.433	4.3	4.85	4.6	4.583				0

[Appendix 3] Rating Data Sorted by Picture Clarity Mean Ratings

	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ
125	179	zebra	6.65	6.9	6.8	6.783	4.95	5.85	5.8	5.533	4.5	4.7	4.55	4.583	1	3		4
126	39	candle	6.4	6.5	6.8	6.567	5.65	6	6.3	5.983	4.3	4.7	4.7	4.567	1	4	9	14
127	44	chain	5.95	6.5	6.3	6.25	5.15	6.4	5.05	5.533	4.35	4.9	4.4	4.55			3	3
128	177	wheel	6.1	7	6.55	6.55	5.9	6.65	6.5	6.35	4.55	4.85	4.25	4.55		3	4	7
129	112	leg	6.15	7	6.7	6.617	6.5	7	6.75	6.75	4.1	4.85	4.65	4.533		1	1	2
130	138	refrigerator	6.2	7	6.8	6.667	6.65	6.95	6.95	6.85	4.4	4.85	4.35	4.533		2		2
131	159	swan	6.6	6.55	6.65	6.6	4.85	6.05	5.75	5.55	4.6	4.6	4.4	4.533		3		3
132	151	sock	6.25	7	6.9	6.717	6.3	6.75	6.85	6.633	4.05	4.85	4.7	4.533	2	3		5
133	131	peacock	6.75	6.8	6.55	6.7	4.65	5.55	5.85	5.35	4.5	4.55	4.5	4.517		2		2
134	94	grasshopper	6.35	6.211	6.45	6.337	5	5.35	5.7	5.35	4.263	4.789	4.45	4.501	3	9	1	13
135	9	ashtray	5.85	6.85	6.55	6.417	5.316	6.75	5.9	5.989	4.053	4.8	4.65	4.501	2	1		3
136	146	slide	5.5	6.368	6.9	6.256	4.85	6.105	6.6	5.852	4.2	4.8	4.5	4.5	1	10		11
137	153	spider	6.5	6.9	6.65	6.683	5.75	6.4	6.45	6.2	4.3	4.85	4.35	4.5		1		1
138	62	crown	6.7	6.9	6.45	6.683	4.8	5.95	5.35	5.367	4.55	4.5	4.35	4.467		1		1
139	68	door	6.1	7	6.8	6.633	6.6	7	6.95	6.85	3.95	4.85	4.55	4.45	5	1	2	8
140	128	ostrich	6.4	6.45	6.25	6.367	4.65	5.55	5.25	5.15	4.35	4.737	4.2	4.429		1		1
141	85	fountain	5.65	6.9	6.6	6.383	5.35	6.25	6.55	6.05	3.95	4.75	4.55	4.417				0
142	157	strawberry	6.55	7	6.7	6.75	5.75	6.55	6.85	6.383	4.05	4.8	4.35	4.4		1		1
143	64	deer	6.35	6.9	6.7	6.65	5.45	5.95	6.35	5.917	4.1	4.8	4.25	4.383	4	4	2	10
144	57	coat	6.15	6.85	6.65	6.55	6.45	6.55	6.05	6.35	4.2	4.55	4.35	4.367	4	13	4	21
145	139	ring	6.15	7	6.95	6.7	6.25	6.7	6.8	6.583	4.048	4.75	4.3	4.366		1	1	2
146	69	dragonfly	6.3	6.8	6.8	6.633	4.55	6	6.4	5.65	3.789	4.444	4.85	4.361	4	6		10
147	78	feather	6.4	6.85	6.4	6.55	5.3	6.7	5.95	5.983	4.65	4.211	4.158	4.339		5	3	8
148	86	fox	6.1	6.7	6.45	6.417	4.9	5.8	6.05	5.583	4.4	4.55	3.95	4.3	1	6		7
149	5	ant	6.65	6.9	6.85	6.8	5.95	6.55	6.55	6.35	4.15	4.25	4.45	4.283		2	2	4
150	91	glove	5.9	6.85	6.9	6.55	5.4	6.9	6.45	6.25	3.75	4.55	4.5	4.267		7		7
151	166	tower	5.55	6.85	6.5	6.3	5.15	6.15	5.55	5.617	3.35	4.75	4.7	4.267	9	9	8	26
152	142	ruler	5.85	6.85	6.5	6.4	5.4	6.8	6.75	6.317	3.4	4.579	4.75	4.243	4	5	4	13
153	74	earth	5.75	6.65	6.4	6.267	5.95	6.4	6.4	6.25	3.85	4.85	4	4.233	7	14	6	27
154	140	roof	5.85	6.95	6.55	6.45	5.9	6.65	6.8	6.45	3.6	4.65	4.4	4.217	1	3		4
155	144	sheep	6.1	6.85	6.3	6.417	5.05	6.05	6	5.7	4.25	4.263	4.1	4.204		8		8

[Appendix 3] Rating Data Sorted by Picture Clarity Mean Ratings

	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ
156	115	map	5.9	6.85	6.45	6.4	5.9	6.3	6.6	6.267	3.25	4.85	4.5	4.2	2	6	5	13
157	27	bowl	6.05	5.95	6.45	6.15	6.4	6.3	6.45	6.383	4.1	4.35	4.05	4.167		9	8	17
158	127	onion	6.15	7	6.6	6.583	6.2	6.85	6.85	6.633	3.8	4.316	4.2	4.105		3	1	4
159	59	cord	5.1	6.55	6.1	5.917	4.85	6.45	5.7	5.667	3.65	4.211	4.45	4.104	20	19	6	45
160	41	cane	5.35	6.75	6.45	6.183	4.5	5.95	5.65	5.367	3.95	4.15	4.15	4.083	10	10	6	26
161	178	window	6.15	7	6.8	6.65	6.35	6.9	6.8	6.683	3.55	4.4	4.3	4.083	1		2	3
162	124	needle	6.4	6.95	6.65	6.667	5.25	6.5	6.6	6.117	3.65	4.4	4.15	4.067		2		2
163	122	necklace	5.75	6.95	6.7	6.467	5.7	6.55	6.7	6.317	3.45	4.5	4.25	4.067	2	3		5
164	4	angel	6.2	6.6	5.35	6.05	5.1	6.3	5.65	5.683	3.7	4.05	4.4	4.05	1		1	2
165	28	box	6.05	6.65	6.65	6.45	6.45	6.9	6.65	6.667	3.4	4.55	4.15	4.033	1		2	3
166	48	chimney	6.15	6.95	6.65	6.583	4.9	6.15	6.55	5.867	3.9	4.2	3.85	3.983		1	1	2
167	95	hair	5.5	6.9	6.55	6.317	6.75	7	7	6.917	3.55	4.15	4.25	3.983	1	7	8	16
168	162	tail	5.45	6.55	6.15	6.05	5.4	6.5	5.95	5.95	3.8	4	3.85	3.883			2	2
169	50	cigar	5.85	6.5	5.55	5.967	4.5	5.8	3.35	4.55	3.7	4.3	3.5	3.833		3	10	13
170	40	candy	5.8	6.65	6.5	6.317	6.05	6.8	6.6	6.483	3.1	4.059	4.25	3.803		5	4	9
171	46	cherry	6.7	6.85	6.45	6.667	5.8	6.3	5.9	6	3.6	4.2	3.6	3.8		2	3	5
172	70	drum	6.25	6.8	6.6	6.55	4.95	6.05	5.8	5.6	3.2	3.95	4.08	3.743	2	2	6	10
173	160	swing	5.9	6.85	6.7	6.483	5	6.45	6.75	6.067	4.1	2.85	4.158	3.703		5	1	6
174	118	mountan	6.15	7	6.8	6.65	5.95	6.55	6.9	6.467	3.25	3.7	4.15	3.7	3	10		13
175	121	nail	5.9	6.9	6.5	6.433	5.737	6.2	6.5	6.146	3.5	3.3	4.25	3.683	3	6	2	11
176	176	watermelon	6.2	7	6.7	6.633	5.5	6.8	6.85	6.383	2.944	4.1	3.684	3.576	4	6	3	13
177	17	bee	6.7	6.6	6.7	6.667	6.05	6.65	6.6	6.433	3.7	3.75	3.2	3.55	2	6	3	11
178	54	closet	5.4	6.2	6.5	6.033	6.4	6.35	6.55	6.433	2.4	3.85	3.8	3.35	15	14	2	31
179	152	soldier	6.25	6.9	6	6.383	5.55	6.3	5.85	5.9	2.526	3.474	3.85	3.283	5	6	9	20
180	55	cloud	6.15	6.85	6.4	6.467	6.3	6.9	6.85	6.683	3	3.35	3.3	3.217		1	1	2
181	35	button	6.1	6.9	6.65	6.55	6.05	6.7	6.95	6.567	2.65	3.35	2.9	2.967	2	1		3
182		**mean**	6.334	6.847	6.729	6.637	5.815	6.49	6.468	6.258	4.418	4.761	4.562	4.58				
183		st deviation	0.361	0.228	0.253	0.211	0.621	0.449	0.541	0.477	0.527	0.379	0.356	0.382				
184		# of selected	110	135	104	107	92	114	111	106	115	129	104	124				

APPENDIX 4

Number of Different Names Provided by Respondents

from the Three Different Language Groups

in the Picture Naming Task

with Specific Different Names for Each Picture Item

in the Three Languages

[Appendix 4] The Numbers and the Kinds of Different Names

I.D.	#T	E: Word	E#	English: other names	S: Word	S#	Spanish: other names	K: Word	K#	Korean: other names
1	12	airplane	11	plane (9), jet (2)	avion	1	jet	비행기		
2	6	alligator			caiman	4	caiman(2), largardga(2)	악어	2	도마뱀 (2)
3	1	anchor			ancla			닻	1	이름모름
4	2	angel	1	fairy	angel			천사	1	선녀
5	4	ant			hormiga	2	DKO	개미	2	곤충, 여치
6	0	apple			manzana			사과		
7	1	arm			brazo			팔	1	
8	16	arrow			flecha	1	arro	화살	15	화살표 (15)
9	3	ashtray	2	coaster, DKO	cenicero	1	cenisa	재털이		
10	6	baby			bebe	6	nino(6)	아기		
11	7	ball	3	beach ball (3)	pelota	1	bol	공	3	비치볼 (2), 볼
12	3	balloon			globo	3	bomba(2), vejega	풍선		
13	28	bat	1	baseball bat	garrote	20	bate(12), bat(5), palo de beisbol, bat de beisbol, DKN	바구니	7	야구배트, 야구방망이(5), 배트
14	4	basket			canasta	2	casta(2)	방망이	2	소풍바구니, 반짓고리
15	5	bear	3	polar bear (3)	oso	1	oso polar	곰	1	불곰
16	1	bed	1	twin bed	cama			침대		
17	11	bee	2	fly, beatle	abeja	6	arana(2), cucorache, insecto(2), pulga	벌	3	벼룩, 그림모름, 이름모름
18	0	bell			campana			종		
19	14	belt			cinturon	6	cinto(4), correa, TOT	벨트	8	belt,혁대(3),허리띠(3),팔찌
20	11	bicycle	10	bike (10)	bicicleta	1	bici	자전거		
21	5	bird			pajaro	1	gorrion	새	4	참새(3), 샌드파이퍼
22	35	boat	10	sailboat(10)	bote	18	barco(6), barquillo de velo, bote de velo(2), buque, lancha, velero(7)	돛단배	7	요트, 돛단배 (6)
23	0	book			libro			책		
24	8	boot	1	cowboyboot	bota			부츠	7	boots(2), 긴장화, 부츠 (4)
25	0	bottle			botella			유리병		
26	6	bow	1	ribbon	mono	5	chonga,lazo(3),recoreo	리본		
27	17	bowl			tazon	9	bol, balla, plato(2), plato hondo, plato sopre, posio, recipiente, DKN	대접	8	그릇(사발)(6), 종기, 주발
28	3	box	1	DKN	caja			상자	2	반지상자, 박스
29	2	bread	1	loaf	pan	1	barra de pan	빵		

[Appendix 4] The Numbers and the Kinds of Different Names

30	0	broom			escoba			빗자루		
31	6	brush	1	hair brush	cepillo	1	cepillo de pelo	솔	4	옷솔(3), 솔빗
32	16	bulb	10	light bulb(10)	foco	5	bombilla(4), lamporita	전구	1	전구
33	10	bus			autobus	9	bus, camioneta, camion(3), camion de pozajeros, guague, omnibus(2)	버스	1	쌤 트랜스
34	3	butterfly			mariposa			나비	3	호랑나비 (3)
35	3	button	2	pie(2)	boton	1	DKO	단추		
36	2	cake			pastel	2	bezcoche, torta	케이크		
37	2	camel			camello	2	dromedario	낙타		
38	2	camera			camara	2	ruspuirea de fotos, camara de fotos	사진기		
39	14	candle	1	candle holder	vela	4	candelabro(2), candil(2)	양초	9	촛불(5),촛대,초,램프,DKN
40	9	candy			dulce	5	caramelo(3), DKO, TOT	사탕	4	그림모름, 캔디(2), 빨대
41	26	cane	10	candy cane (10)	baston	10	baston de dulce(3), caramelo(2), dulce(3), garrota, DKN	지팡이	6	스틱캔디,3캔디케인,박하사탕,지팡이사탕
42	7	car			carro	7	auto(2), coche(5)	자동차		
43	6	cat	5	kitten (5)	gato	1	galito	고양이		
44	3	chain			cadena			사슬	3	체인 (3)
45	1	chair			silla			의자	1	걸상
46	5	cherry			cereza	2	durazuo, TOT	앵두	3	체리, 버찌(2)
47	21	chicken	6	hen(5), rooster	pollo	14	gallina(14)	닭	1	암탉
48	2	chimney			chimenea	1	TOT	굴뚝	1	연기
49	3	church	1	Christian church	iglesia	2	templo(2)	교회		
50	13	cigar			puro	3	cigarro(2), tabacco	궐련	10	시가(3),담배(2),크레용(4),DKN
51	1	cigarette			cigarro			담배	1	담배불
52	4	circle			circulo	1	luna llena	동그라미	3	보름달, 해 , 원
53	3	clock			reloj	2	despertador(2)	시계	1	탁상시계
54	31	closet	15	cabinet(8), dresser(4), cupboard(2), bureau	gabinete	14	[illegible]	옷장	2	장롱, 장
55	2	cloud			nube	1	roca	구름	1	그림모름
56	4	clown			payaso	1	TOT	광대	3	어릿광대, 꼬두각시,DKN
57	21	coat	4	jacket(2), overcoat(2)	saco	13	abrigo(10), sobretodo, tombeviento, traje	코우트	4	외투 , 자켓 , 가운, 오버코트
58	4	comb			peine	2	cepillo, TOT	머리빗	2	머리빗 (2)
59	45	cord	20	knot(12), rope(8)	cordon	19	cordon(2), cuerda(2), lozo(2), lazo alado, nudo(9), riata, soga nudo, zoga	노끈	6	밧줄 (5), 새끼줄

[Appendix 4] The Numbers and the Kinds of Different Names

60	9	corn	1	corn husk	maiz	8	choclo, maiz(4), mazorca(3)	옥수수		
61	1	cow			vaca			소	1	젖소
62	1	crown			corona	1	TOT	왕관		
63	23	cup	1	tea cup	copa	19	taza(19)	커피잔	3	cup, 찻잔, 컵
64	10	deer	4	elk(2), buck(2)	venado	4	ciervo(3), animal de Santa Clause	사슴	2	숫사슴, 순록
65	0	desk			escritorio			책상		
66	6	dog			perro			개	6	강아지 (6)
67	5	donkey	2	mule, pony	burro	1	TOT	당나귀	2	노새, 망아지
68	8	door	5	doorway(3), doorframe, doorjam	puerta	1	puerta abierta	문	2	문설주, 열린문
69	10	dragonfly	4	insect, moth, DKN, TOT	caballito	6	abupa, insecto, mosca, DKN, TOT	잠자리		
70	10	drum	2	tamborine(2)	tambor	2	pandero, padereta	북	6	탬버린(2), 드럼(3), 작은북
71	0	duck			pato			오리		
72	2	eagle			aguila	2	gaviota, TOT	독수리		
73	7	ear			oreja	7	oido(7)	귀		
74	27	earth	7	globe(6), world	la tierra	14	continente(2), globo(2), globo terrapuso(2), mapa de America, Mapa mundi, mundo(5), planeta	지구	6	지구본 (5), 그림모름
75	0	elephant			elefante			코끼리		
76	2	envelope			sobre			봉투	2	편지봉투 (2)
77	1	eye			ojo			눈	1	눈동자
78	8	feather			pluma	5	hoja, once, DKO, TOT	깃털	3	깃털펜, 이름모름, 그림모
79	0	finger			dedo			손가락		
80	12	fish			pescado	10	pez(10)	물고기	2	생선, 붕어
81	17	flag			bandera	1	America bandera	깃발	16	국기(성조기)(12), 미국기(4)
82	5	flower	1	daisy	flor	2	girasol,violeta	꽃	2	코스모스, 이름모름
83	0	foot			pie			발		
84	0	fork			penedor			포오크		
85	0	fountain			fuente			분수		
86	7	fox	1	wolf	zorro	6	coyote, lobo(3), perro(2)	여우		
87	13	frog	1	toad	sapo	11	rana(11)	개구리	1	두꺼비
88	1	giraffe			cebra	1	TOT	기린		
89	3	glass			vidrio			유리컵	3	glass, 컵, 유리잔

[Appendix 4] The Numbers and the Kinds of Different Names

90	14	glasses			anteojos	13	espeguelo, gafas(1), lentes(11)	안경	1	안경테
91	7	glove			guante	7	mono(6), mano guante	장갑		
92	11	goat			chivo	11	caba, cabra(8), ciervo, TOT	염소		
93	2	grapes			uvas	2	ramo de vua(2)	포도		
94	13	grasshopper	3	cricket(2), DKO	saltamontes	9	chapulin(3), langasta, saltamontes(3), DKN(2)	메뚜기	1	여치
95	16	hair	1	cap	pelo	7	cabello(2), cabeza(2), hongo, nucz, TOT	머리카락	8	조개(4), 그림모름(4)
96	0	hammer			martillo			망치		
97	0	hand			mano			손		
98	4	hanger	1	coathanger	gancho	3	percha(3)	옷걸이		
99	1	harp			arpa	1	TOT	하아프		
100	1	hat			sombrero			모자	1	중절모
101	2	helicopter			helicoptero			헬리콥터	2	헬기 (2)
102	1	horse	1	colt	caballo			말		
103	2	house			casa			집	2	이층집 (2)
104	0	iron			plancha			다리미		
105	21	kettle	5	teapot(2), teakettle(3)	caldera	16	cafetera(3), olla(2), peva, tetera(8), DKN(2)	주전자		
106	0	key			llave			열쇠		
107	14	kite			cometa	14	borrilete, chimgas, papagayo, papalote(10), piscucha	연		
108	2	knife			cuchillo			칼	2	과도, knife
109	0	ladder			escalera			사다리		
110	5	lamp			lampara			램프	5	전등,전기스텐드,2스텐드,전기다마끼는것
111	1	leaf			hoja	1	TOT	잎사귀		
112	2	leg			pierna	1	cania	다리	1	발
113	1	lion			leon			사자	1	숫사자
114	7	lips			labios	7	boca(7)	입술		
115	13	map	2	world continents, DKO	mapa	6	continentes(2),mapa mundi(3),mundo	지도	5	세계지도
116	5	monkey			mono	5	chango(5)	원숭이		
117	8	moon	1	crescent moon	luna			달	7	그믐달, 초승달 (6)
118	13	mountan	3	volcano (3)	montana	10	vocan(7),cumbre,monte,TOT	산		
119	2	mouse			raton	2	mouse, rata	쥐		

[Appendix 4] The Numbers and the Kinds of Different Names

120	1	mushroom			hongo	1	hongo seta	버섯		
121	11	nail	3	hyperdermic needle, syringe(2)	clavo	6	lapiz(3), geringilla, jeringa, termometro	못	2	연필, 주사기
122	5	necklace	2	beads(2)	collar	3	cadena(3)	목걸이		
123	18	necktie	18	tie (18)	corbata			넥타이		
124	2	needle			aguja	2	abuja, pincel	바늘		
125	4	newspaper	2	paper(2)	periodico	1	dario	신문	1	책
126	0	nose			nariz			코		
127	4	onion			cebolla	3	granada, higo, DKO	양파	1	마믈
128	1	ostrich			avestruz	1	TOT	타조		
129	21	owl			tecolote	15	buho(13), leclueza, mucaro	올빼미	6	부엉이 (6)
130	2	pants	1	trousers	pantalon			바지	1	여자바지
131	2	peacock			pavoreal	2	pavo, DKN	공작		
132	0	pencil			lapiz			연필		
133	3	piano	1	grand piano	piano			피아노	2	그랜드파아노 (2)
134	13	pig			cerdo	12	chencho, cochino(4), puerco(7)	돼지	1	멧돼지
135	17	pistol	16	gun(15), revolver	pistola			권총	1	총
136	19	purse	1	bag	bolsa	7	cartera(6), mochila	지갑	11	4가방, 4핸드백, 어깨끈가방, 백, 손가방
137	0	rabbit			conejo			토끼		
138	2	refrigerator			refrigerador	2	nevera, TOT	냉장고		
139	2	ring			anillo	1	TOT	반지	1	꽃반지
140	4	roof	1	gable roof	techo	3	teja,tejado(2)	지붕		
141	3	rose	2	flower(2)	rosa	1	flor	장미		
142	13	ruler	4	folding ruler, tape measure, yardstick, TOT	regla	5	metro(2), anta de medor, DKN, TOT	자	4	접자(3), 격자
143	0	scissors			tijeras			가위		
144	8	sheep			lampara	8	benado, oveja(7)	양		
145	3	shoe			zapato			신발	3	골프화, 구두(2)
146	11	slide	1	shute	resbaladilla	10	choreja, deslisadero(2), revaladero(4), tobogan(3)	미끄럼틀		
147	1	snail			caracol	1	baboso	달팽이		
148	11	snake			culebra	11	ruibora, serpiente(7), vibora(3)	뱀		
149	15	sneaker	7	shoe(6), tennis shoe	tenis	7	zapato(4), zapato de temos(2), zapatillo	운동화	1	조깅화

[Appendix 4] The Numbers and the Kinds of Different Names

150	11	snowman			muneco de nieve	11	hombre de nieve, mono, muñeco(3), muñeco de nieve(3), onc noconosco	눈사람		
151	5	sock	2	stocking (2)	calcetin	3	media(3)	양말		
152	20	soldier	5	person, woman, man, DKO(2)	soldado	6	mujer(2), hombre, persona, venedor, TOT	군인	9	4DKO,여자,농부,사람,동생,DKN
153	1	spider			arana	1	TOT	거미		
154	5	spoon			cuchara			숫가락	5	티스푼, 스푼, 수저(3)
155	6	stamp			estampilla	6	timbre(4), cello, stampilla	우표		
156	2	star			estrella	1	axuz	별	1	sash
157	1	strawberry			fresa	1	frutilla	딸기		
158	2	sun			sol			해	2	태양 (2)
159	3	swan			cisne	3	gauso,TOT, DKN	백조		
160	6	swing			resbaladilla	5	hamoco,onc notonosco,puerta,ventana,DKN	그네	1	그림모름
161	2	table			mesa			탁자	2	상, table
162	2	tail			cola			꼬리	2	말꼬리, 그림모름
163	0	telephone			telefono			전화		
164	4	tiger			tigre	4	gato,gato motès,leopardo,puma	호랑이		
165	11	toothbrush	2	brush(2)	cepillo de dientes	9	cepillo(9)	칫솔		
166	26	tower	9	Eiffel Tower(8), Paris	torre	9	Arc de Paris, Torre de Paris, Torre Eiffel, TOT	탑	8	에펠탑(7), 파리
167	2	train			tren	1	ferro carriel	기차	1	기동차
168	16	tree	1	pine tree	arbol	12	pino(12)	나무	3	소나무, 크리스마스츄리, 이름모름
169	1	triangle			triangulo			삼각형	1	정삼각형
170	8	truck			camion	7	camion de cargo, trailer(4), troca, truck	트럭	1	화물차
171	7	turkey			pavo	7	chonpipe, guajolote(5), pavoreal	칠면조		
172	2	turtle	2	tortoise(2)	tortuga			거북이		
173	9	umbrella	1	parasol	paraguas	8	sombrilla(8)	우산		
174	4	violin	1	guitar	violin	2	guitara(2)	바이올린	1	기타아
175	2	watch	1	wrist watch	reloj	1	reloj de pulsera	손목시계		
176	13	watermelon	4	DKO(2), melon(2)	sandia	6	guesadilla(2), melón(3), pedazo de zandia	수박	3	그림모름(2), 만두
177	7	wheel			rueda	3	TOT, llanta, ruenda de carreta	바퀴	4	수레바퀴(3), 마차바퀴
178	3	window	1	window shutters	ventana			창문	2	창, 이름모름
179	4	zebra	1	toy	cebra	3	zebra(3)	얼룩말		
180	5	zipper			cierre	5	ciper(2), cremallera, zipper, zuper	지퍼		

APPENDIX 5

Selected 60 Items (Words and Pictures)

from the Stimulus Item Selection Study (Study II)

for Bilingual Memory Research

[Appendix 5] 60 Stimulus Items Selected in Study II

(Words in Three Languages (English, Spanish, and Korean) and Pictures)

1. apple
manzana
사과

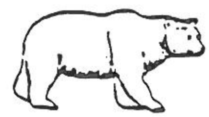
2. arm
brazo
팔

3. baby
bebé
아기

4. balloon
globo
풍선

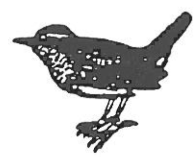
5. basket
canasta
바구니

6. bear
oso
곰

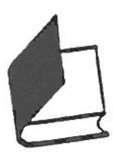


7. bed
cama
침대

8. bird
pajaro
새



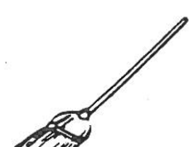
9. book
libro
책



10. bottle
botella
유리병

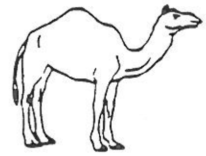
11. bread
pan
빵

12. broom
escoba
빗자루



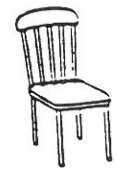
13. butterfly
mariposa
나비

14. camel
camello
낙타



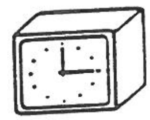
15. cat
gato
고양이

16. chair
silla
의자



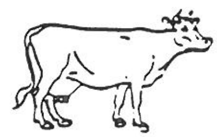
17. cigarette
cigarro
담배

18. clock
reloj
시계

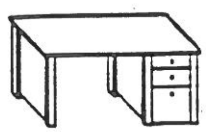


19. comb
peine
머리빗

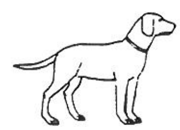
20. cow
vaca
소



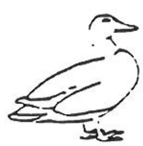
21. desk
escritorio
책상



22. dog
perro
개

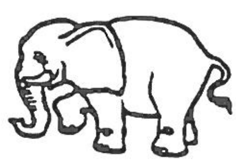


23. duck
pato
오리



24. eagle
águila
독수리

25. elephant
elefante
코끼리



26. finger
dedo
손가락

27. flower
flor
꽃

28. giraffe
jirafa
기린

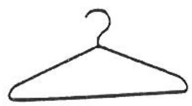
29. grapes
uvas
포도

30. hammer
martillo
망치

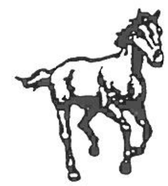
31. hand
mano
손

32. hat
sombrero
모자

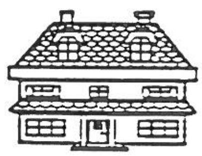
33 hanger
gancho
옷걸이



34. horse
caballo
말

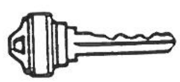


35 house
casa
집

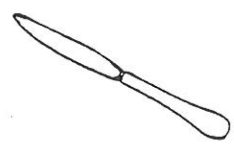


36. iron
plancha
다리미

37. key
llave
열쇠

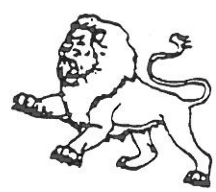


38. knife
cuchillo
칼

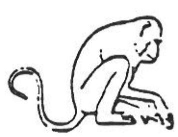


39. ladder
escalera
사다리

40. lion
león
사자



41. monkey
mono
원숭이



42. mouse
ratón
쥐

43. mushroom
hongo
버섯

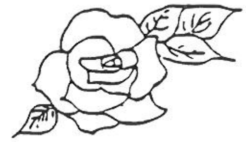
44. nose
nariz
코

45. pants
pntalón
바지

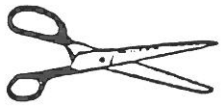
46. pencil
lápiz
연필

47. rabbit
conejo
토끼

48. rose
rosa
장미



49. scissors
tijeras
가위



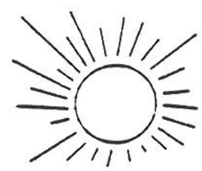
50. shoe
zapato
신발

51. snail
caracol
달팽이

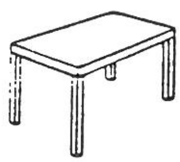
52. spoon
cuchara
숫가락

53. star
estrella
별

54. sun
sol
해

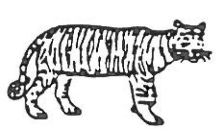


55. table
mesa
탁자



56. telephone
teléfono
전화

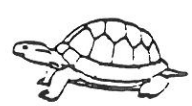
57. tiger
tigre
호랑이



58. train
tren
기차

59. tree
árbol
나무

60. turtle
tortuga
거북이



APPENDIX 6

Proficiency Scale Development

in the Two Languages of Bilinguals:

Description of the Proficiency Questionnaire

and Statistical Procedures in Developing the Proficiency Scale

used in Bilingual Memory Study (Study III)

Proficiency Scale Development in the Two Languages of Bilinguals

Proficiency Questionnaire Development

In order to obtain a proficiency level of the two languages of each subject who participated in the bilingual memory study in this dissertation (Study III), a subjective measure of proficiency based on a self-judgment method was used. A questionnaire of forty descriptions of language use was developed (see the attached Questionnaire for Proficiency Measure at the back of this Appendix). Descriptions of forty situations were made based on the verbal descriptions from the Can-do (Clark, 1981) ratings of self-proficiency, the ACTFL (American Council on the Teaching of Foreign Languages) speaking proficiency guidelines, and FSI (Foreign Service Institute) scales. 10 items (situations of language use) were prepared per each language skill from the very easy tasks (e.g., order a simple meal in a restaurant, write a shopping list) to the relatively hard tasks (e.g., debate a controversial topic properly, read highly technical reports). These items were randomly mixed within each skill for subjects not to notice the degree of difficulty of the items in order. Subjects were asked to judge their own proficiency on each item on a five-point scale from 1 (cannot do it at all) to 5 (can do it comfortably). Subjects could mark their proficiency either on the number or somewhere in-between based on their self-judged proficiency level.

Analysis of Rating Data and Proficiency Scale Development

The proficiency scale scores were analyzed by a factor analysis with varimax rotation to see the communality of the items. Separate factor analyses with 10 items in each language skill (listening, speaking, reading, and writing) for each of the two languages of the bilinguals (English and Korean for the Korean-English bilingual group or English and Spanish for the Spanish-English bilingual group). The results showed that all 10 items for each language skill loaded onto one factor for both bilingual groups. Based on the result of these separate factor analyses, four scores were produced in each language one for each skill by getting a mean score from 10-item scores. To determine whether the scales were internally consistent (reliable), Cronbach's alpha was calculated. Cronbach's alpha

coefficients were over 0.90 for all 8 scales in the Korean group and the Spanish group also showed very high internal consistency with all scales resulting in alphas of 0.85 or better.

Correlations among the four language skill scales within each language and also across the two languages were calculated for both bilingual groups. The interscale correlations showed that these scales were significantly related to each other within and across the languages (see Tables A6-1 and A6-2).

Factor analyses of all 40 items in each language (English and Korean/Spanish) were computed. Results of the factor analyses proved that the 40 items loaded onto a single factor. Total explained variance of the English proficiency scale for the Korean group was 66.45 % and the eigenvalue for this factor was 26.58. The lowest factor loading was 0.60 ("understand simple questions") and 28 items had loadings over 0.80. The Korean proficiency scale also had a very high percent of total explained variance (79.86 %) and the eigenvalue for the one factor was 31.94. The lowest item loading was 0.64 for the same item which also appeared in the English proficiency scale and 35 items had loadings over 0.80.

For the Spanish group, total explained variance of the English proficiency scale was 53.19 % and the eigenvalue for the one factor solution was 21.28. There were three items with low factor loadings ("understand simple questions": [0.24]; "understand a native speaker who is speaking very slowly in a face-to-face conversation": [0.17]; and "read instructions to assemble an audio system": [0.35]). However, according to the result of the separate factor analyses with 10 items for each language skill, these items had been included in a part of the single factor. Thus, all 40 items were considered to consist of one factor. Sixteen items had loadings of over 0.80. For the Spanish proficiency scale, total explained variance was 62.04 % and the eigenvalue for this one factor was 24.82. The lowest factor loading was 0.54 and 19 items had loadings of over 0.80.

Since all four scales for each language skill were significantly correlated to each other and since factor analysis found all 40 items to load onto a single factor, one scale score was computed for each language for each subject. Thus, subjects in the Korean group had two scale scores, one for English proficiency and one for Korean proficiency. Similarly, subjects in the Spanish group also had two scale scores, one for English and one for Spanish. Based on these two scale scores for each subject, subjects were grouped into three different categories: a balanced-bilingual group, an English-dominant group, and a Korean (or Spanish)-dominant group.

[Table A6-1] Correlation between Language Skills (Korean-English Bilinguals)

PEARSON CORRELATION MATRIX

	ENGLISHS speak	ENGLISHL listen	ENGLISHR read	ENGLISHW write	KOREANS speak
ENGLISHS	1.000				
ENGLISHL	0.926	1.000			
ENGLISHR	0.875	0.879	1.000		
ENGLISHW	0.894	0.928	0.911	1.000	
KOREANS	-0.542	-0.590	-0.518	-0.562	1.000
KOREANL	-0.538	-0.572	-0.504	-0.550	0.952
KOREANR	-0.603	-0.639	-0.554	-0.608	0.960
KOREANW	-0.613	-0.641	-0.562	-0.588	0.932

	KOREANL listen	KOREANR read	KOREANW write
KOREANL	1.000		
KOREANR	0.951	1.000	
KOREANW	0.904	0.949	1.000

BARTLETT CHI-SQUARE STATISTIC: 2242.820 DF= 28 PROB= 0.000

MATRIX OF BONFERRONI PROBABILITIES

	ENGLISHS speak	ENGLISHL listen	ENGLISHR read	ENGLISHW write	KOREANS speak
ENGLISHS	0.000				
ENGLISHL	0.000	0.000			
ENGLISHR	0.000	0.000	0.000		
ENGLISHW	0.000	0.000	0.000	0.000	
KOREANS	0.000	0.000	0.000	0.000	0.000
KOREANL	0.000	0.000	0.000	0.000	0.000
KOREANR	0.000	0.000	0.000	0.000	0.000
KOREANW	0.000	0.000	0.000	0.000	0.000

	KOREANL listen	KOREANR read	KOREANW write
KOREANL	0.000		
KOREANR	0.000	0.000	
KOREANW	0.000	0.000	0.000

NUMBER OF OBSERVATIONS: 164

[Table A6-2] Correlation between Proficiency Scales (Spanish-English Bilinguals)

PEARSON CORRELATION MATRIX

	ENGLISHS speak	ENGLISHL listen	ENGLISHR read	ENGLISHW write	SPANISHS speak
ENGLISHS	1.000				
ENGLISHL	0.879	1.000			
ENGLISHR	0.782	0.814	1.000		
ENGLISHW	0.891	0.873	0.808	1.000	
SPANISHS	-0.384	-0.412	-0.342	-0.400	1.000
SPANISHL	-0.327	-0.317	-0.271	-0.332	0.833
SPANISHR	-0.409	-0.416	-0.324	-0.407	0.894
SPANISHW	-0.376	-0.376	-0.305	-0.353	0.868

	SPANISHL listen	SPANISHR read	SPANISHW write
SPANISHL	1.000		
SPANISHR	0.846	1.000	
SPANISHW	0.783	0.920	1.000

BARTLETT CHI-SQUARE STATISTIC: 1658.477 DF= 28 PROB= 0.000

MATRIX OF BONFERRONI PROBABILITIES

	ENGLISHS speak	ENGLISHL listen	ENGLISHR read	ENGLISHW write	SPANISHS speak
ENGLISHS	0.000				
ENGLISHL	0.000	0.000			
ENGLISHR	0.000	0.000	0.000		
ENGLISHW	0.000	0.000	0.000	0.000	
SPANISHS	0.000	0.000	0.000	0.000	0.000
SPANISHL	0.000	0.001	0.008	0.000	0.000
SPANISHR	0.000	0.000	0.000	0.000	0.000
SPANISHW	0.000	0.000	0.001	0.000	0.000

	SPANISHL listen	SPANISHR read	SPANISHW write
SPANISHL	0.000		
SPANISHR	0.000	0.000	
SPANISHW	0.000	0.000	0.000

NUMBER OF OBSERVATIONS: 176

Subject Grouping into Three Proficiency Groups

Each subject got two scale scores one for each language based on the self-rated proficiency scores in four language skills. Since an important assumption in subject selection was that subjects had to possess a native-like proficiency at least in one of their two languages, subject grouping was conducted based on the two proficiency scores for each subject. If the mean scale score of both languages was high, then the subject was classified into a balanced bilingual group. If the scale score of English was high, but that of the other language (Korean or Spanish) was not high, then the subject was categorized as English-dominant. Finally, if the proficiency rating for English was low but that of the other language was high, then the subject was classified Korean (or Spanish)-dominant.

The proficiency scale score of 4.35 or above in both languages of the bilingual was used to classify balanced bilingual subjects from subjects who were unbalanced and dominant in only one language. The scale score 4.35 was chosen as the proficiency level in dividing bilingual subjects between balanced and unbalanced groups because the subject grouping using the 4.35 proficiency level looked most similar to the initial grouping of subjects done by the short screening interview before administering the questionnaire. As a result, the subject distribution into three proficiency groups was done as seen in Table A6-3.

[Table A6-3] Subject Distribution into Three Proficiency Groups

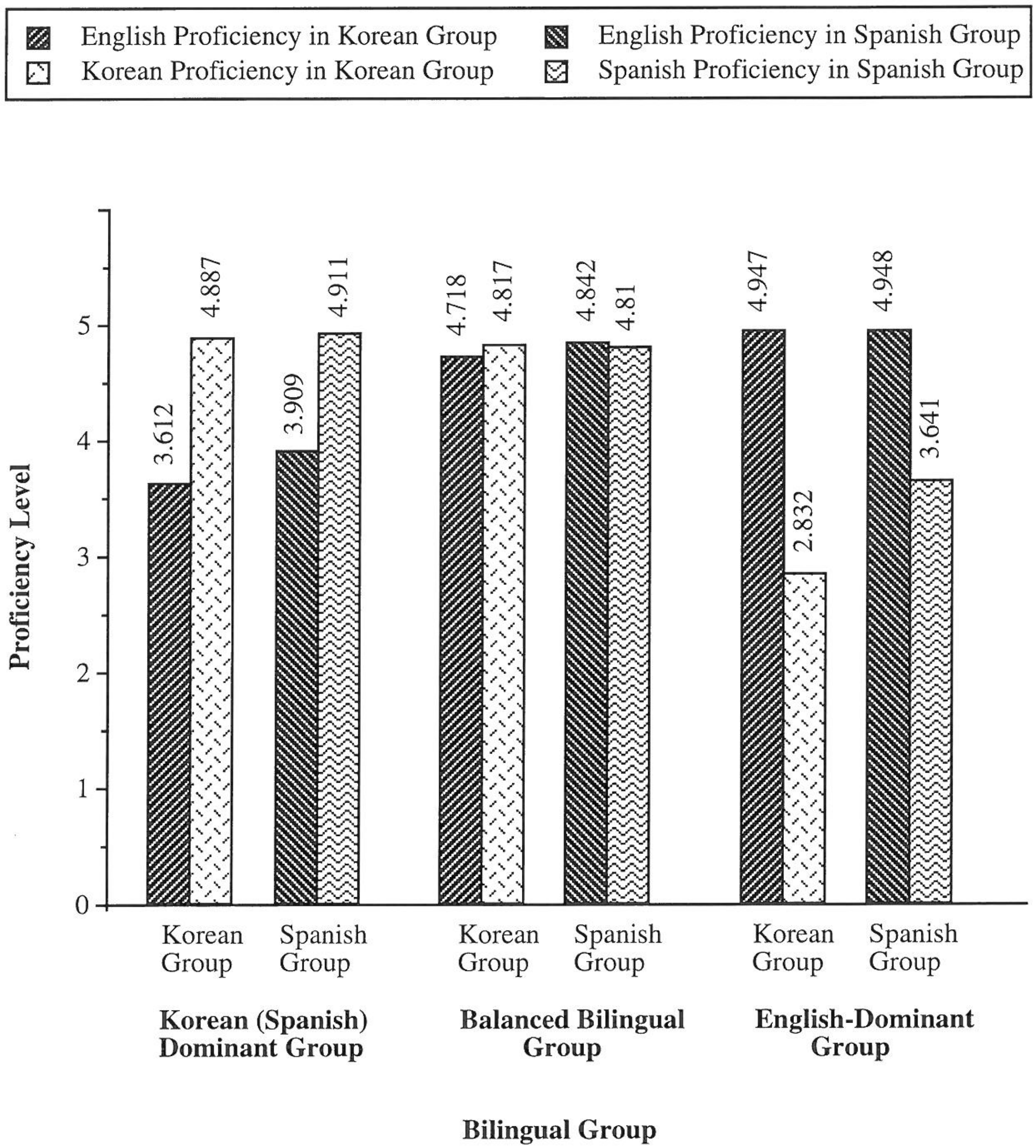
	Korean (Spanish)-dominant Group	Balanced Group	English-dominant Group	Total
Korean Group	72	37	55	164
Spanish Group	24	81	71	176

For the Korean-English bilingual group, the English proficiency mean score for the Korean-dominant subjects was 3.612 and their Korean proficiency mean score was 4.887. English and Korean proficiency mean scores for the balanced subjects were 4.718 and 4.817 respectively; and for the English-dominant subjects, the mean scores were 4.947 for English and 2.832 for Korean. For the Spanish-English bilingual group, English and Spanish mean scores were 3.909 and 4.911 for the Spanish-dominant subjects, 4.842 and 4.810 for the balanced subjects, and 4.948 and 3.641 for the English-dominant subjects. Mean proficiency scores for the two languages of the bilinguals for both the Korean-English and Spanish-English groups are depicted in Figure A6-1 by the three different bilingual groups.

There was a significant difference in English proficiency scores among three different bilingual groups for both the Korean-English and Spanish-English groups (for the Korean-English group, $F(2, 161) = 308.46$, $p < .0001$; for the Spanish-English group, $F(2, 173) = 250.72$, $p < .0001$). English proficiency for both the Korean-dominant and Spanish-dominant groups was significantly lower than that of the balanced and English-dominant groups, $p < .0001$. English proficiency for the balanced group was also significantly lower than that of the English-dominant group for both the Korean-English group, $p < .002$, and the Spanish-English group, $p < .001$. On the other hand, Korean proficiency for the English-dominant subjects was significantly lower than that of the balanced and Korean-dominant subjects, $F(2, 161) = 465.45$, $p < .0001$. However, Korean proficiency between the balanced and Korean-dominant subjects was not significantly different. Spanish proficiency for the English-dominant subjects was also significantly lower than that of the balanced and Spanish-dominant subjects, $F(2, 173) = 250.72$, $p < .0001$. Spanish proficiency between the balanced and Spanish-dominant subjects, however, was not significantly different.

A significant age difference between the three proficiency groups was found for both the Korean-English and Spanish-English bilingual groups (for the Korean-English group, $F(2, 160) = 52.93$, $p < .0001$; for the Spanish-English group, $F(2, 170) = 4.92$, $p < .008$). For both groups, the English-dominant subjects were significantly younger than the Korean (Spanish)-dominant or balance subjects. Mean age of the English-dominant subjects was 20.67 for the Korean-English group and 23.63 for the Spanish-English group. On the other hand, mean age of the balanced subjects for the Korean-English and Spanish-English groups was 30.19 and 26.24 respectively, and mean age of the Korean (or Spanish)-dominant subjects was 29.68 and 28.04, respectively.

[Figure A6-1] Mean Proficiency Scores in Two Languages of Bilingual Subjects



Questionnaire for Proficiency Measure

(An example questionnaire for Korean-English bilingual subjects)

Proficiency Questionnaire

The following are descriptions of various common situations. Please read each statement and decide your ability to complete the task using the 5-point scale shown below which ranges from 1: "cannot do it at all" to 5: "can do it comfortably". In marking your self-ratings you are also asked to do it for English (left column) and Korean (right column). It may be true that for some tasks you will feel more confident in one or the other language. Do not worry if your self-ratings vary in the two languages. You will have about 8 minutes.

1: cannot do it at all
2: with great difficulty
3: with some difficulty
4: quite comfortably but with occasional difficulty
5: can do it comfortably

Speaking Items

	English	Korean
1. Order a simple meal in a restaurant	1-----2-----3-----4-----5	1-----2-----3-----4-----5
2. Ask for directions on the street	1-----2-----3-----4-----5	1-----2-----3-----4-----5
3. Buy clothes in a department store	1-----2-----3-----4-----5	1-----2-----3-----4-----5
4. Introduce myself in social situations	1-----2-----3-----4-----5	1-----2-----3-----4-----5
5. Describe my major life activities (e.g., hobby, work, family, etc.) accurately and in detail	1-----2-----3-----4-----5	1-----2-----3-----4-----5
6. Tell what I plan to do 5 years from now	1-----2-----3-----4-----5	1-----2-----3-----4-----5
7. Tell a folk tale to children	1-----2-----3-----4-----5	1-----2-----3-----4-----5
8. Describe the educational system	1-----2-----3-----4-----5	1-----2-----3-----4-----5
9. Debate a controversial topic (e.g., birth control, nuclear safety) properly	1-----2-----3-----4-----5	1-----2-----3-----4-----5
10. Give an hour-long lecture about Korea in an American high school classroom	1-----2-----3-----4-----5	1-----2-----3-----4-----5

Listening Comprehension

	English	Korean
11. Understand simple questions (e.g., where do you live? What time is it?)	1-----2-----3-----4-----5	1-----2-----3-----4-----5
12. Understand a native speaker who is speaking very slowly in a face-to-face conversation	1-----2-----3-----4-----5	1-----2-----3-----4-----5
13. Understand a native speaker's slow talk on the phone	1-----2-----3-----4-----5	1-----2-----3-----4-----5
14. Understand a native speaker who is speaking normally in a face-to-face conversation	1-----2-----3-----4-----5	1-----2-----3-----4-----5
15. Understand a native speaker who is speaking normally on the phone	1-----2-----3-----4-----5	1-----2-----3-----4-----5
16. Understand movies without subtitles	1-----2-----3-----4-----5	1-----2-----3-----4-----5
17. Understand news on the radio	1-----2-----3-----4-----5	1-----2-----3-----4-----5
18. Understand sports events on the radio	1-----2-----3-----4-----5	1-----2-----3-----4-----5
19. Understand two native speakers talking rapidly to each other	1-----2-----3-----4-----5	1-----2-----3-----4-----5
20. On the telephone, understand a native speaker who is talking as quickly and as colloquially as he or she would to another native speaker	1-----2-----3-----4-----5	1-----2-----3-----4-----5

Reading Proficiency

	English	Korean
21. Read, on store fronts, the type of store or the services provided (e.g., "dry cleaning," "book store," etc.)	1-----2-----3-----4-----5	1-----2-----3-----4-----5
22. Understand food labeling or instructions on medicine bottles	1-----2-----3-----4-----5	1-----2-----3-----4-----5
23. Understand newspaper headlines	1-----2-----3-----4-----5	1-----2-----3-----4-----5
24. Read newspaper advertisement	1-----2-----3-----4-----5	1-----2-----3-----4-----5
25. Follow directions from a cooking recipe	1-----2-----3-----4-----5	1-----2-----3-----4-----5
26. read instructions to assemble an audio system	1-----2-----3-----4-----5	1-----2-----3-----4-----5
27. Read and understand news magazine without using a dictionary	1-----2-----3-----4-----5	1-----2-----3-----4-----5
28. Read popular novels	1-----2-----3-----4-----5	1-----2-----3-----4-----5
29. Read newspaper editorials	1-----2-----3-----4-----5	1-----2-----3-----4-----5
30. Read highly technical reports	1-----2-----3-----4-----5	1-----2-----3-----4-----5

Writing Proficiency

	English	Korean
31. Write a shopping list	1-----2-----3-----4-----5	1-----2-----3-----4-----5
32. Fill out a job application form	1-----2-----3-----4-----5	1-----2-----3-----4-----5
33. Make a note to a house repair person	1-----2-----3-----4-----5	1-----2-----3-----4-----5
34. Keep a diary every day	1-----2-----3-----4-----5	1-----2-----3-----4-----5
35. Write a newspaper advertisement	1-----2-----3-----4-----5	1-----2-----3-----4-----5
36. Write a letter to a friend	1-----2-----3-----4-----5	1-----2-----3-----4-----5
37. Write a biographical essay	1-----2-----3-----4-----5	1-----2-----3-----4-----5
38. Write a summary of a book	1-----2-----3-----4-----5	1-----2-----3-----4-----5
39. Write a formal business letter	1-----2-----3-----4-----5	1-----2-----3-----4-----5
40. Write a technical report	1-----2-----3-----4-----5	1-----2-----3-----4-----5

APPENDIX 7

Analysis and Results of Task 1 (Coding Task)

in Bilingual Memory Study (Study III)

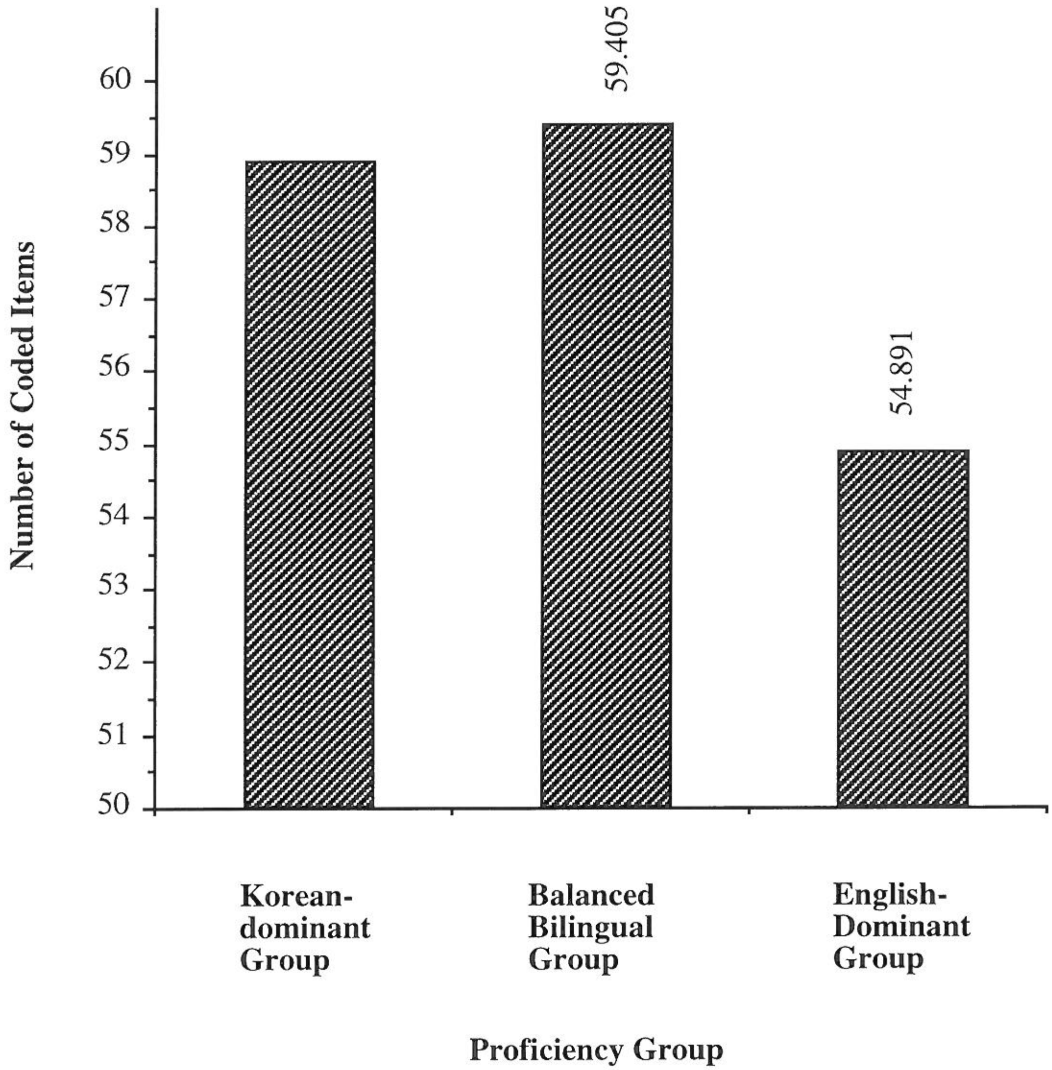
Analysis and Results of Task 1 (Coding Task)

In Study III (Bilingual Memory Representation: Further Application of the Bilingual Dual Coding Model to Korean-English and Spanish-English Bilinguals with Varying Degrees of Bilinguality), subjects were shown 60 stimulus items on slides: 20 pictures, 20 English words, and 20 Korean/Spanish words. They were then asked to write the name of the picture, translate the word, or simply copy the word. This process was a Coding Task (Task 1). The number of items that was coded (i.e., successfully written down as requested) was analyzed by coding condition (Picture-Naming, Translation, and Copying conditions) between the three proficiency groups (English-dominant, Balanced, and Korean/Spanish-dominant groups). Since half of the 60 items were required to be coded in English and the other half in Korean (or Spanish), the comparison was also computed by coding language as well as with the other two variables. Coding data for each of the two language groups (Korean-English and Spanish-English bilingual groups) was first analyzed separately, then between-group comparisons were performed.

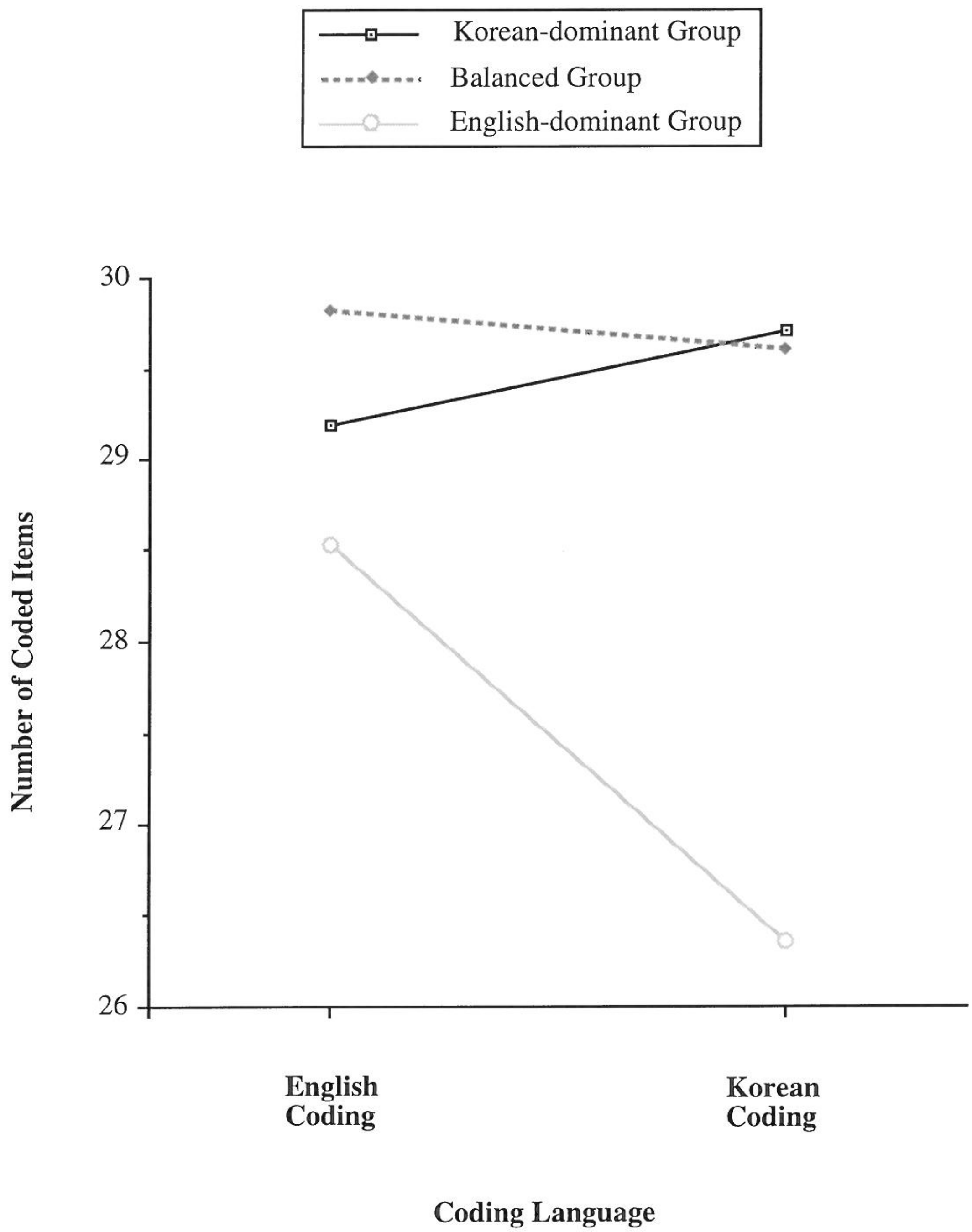
Korean-English Bilingual Data

There was a significant difference in total number of coded items in Task 1 between the three different proficiency groups, F (2, 161) = 32.454, $p < .0001$, (see Figure A7-1). Tukey's HSD multiple comparisons showed that a significant difference in number of coded items was found between the English-dominant group and the other two groups, $p < .0001$. The English-dominant group (M = 54.9) coded significantly fewer items than both the Korean-dominant group (M = 58.9), t (125) = 6.807, $p < .0001$, and the Balanced group (M = 59.4), t (90) = 5.394, $p < .0001$, but no difference was found between the Korean-dominant and Balanced groups. A significant difference in number of coded items was also noted between English coding (M = 29.1) and Korean coding (M = 28.6), t (163) = 3.128, $p = .002$. However, the pattern of the difference in number of coded items between the two language codings differed according to the subject's proficiency group (see FigureA7-2). A two-way ANOVA (Analysis of Variance) for coding language and proficiency group revealed not only a significant difference in number of coded items by coding language and by proficiency group, but also a significant interaction between coding language and proficiency group, F (2, 161) = 32.405, $p < .0001$.

[Figure A7-1] Total Mean Difference in Number of Coded Items for the Three Korean Proficiency Groups



[Figure A7-2] Mean Difference in Number of Coded Items for the Three Korean Proficiency Groups by Coding Language

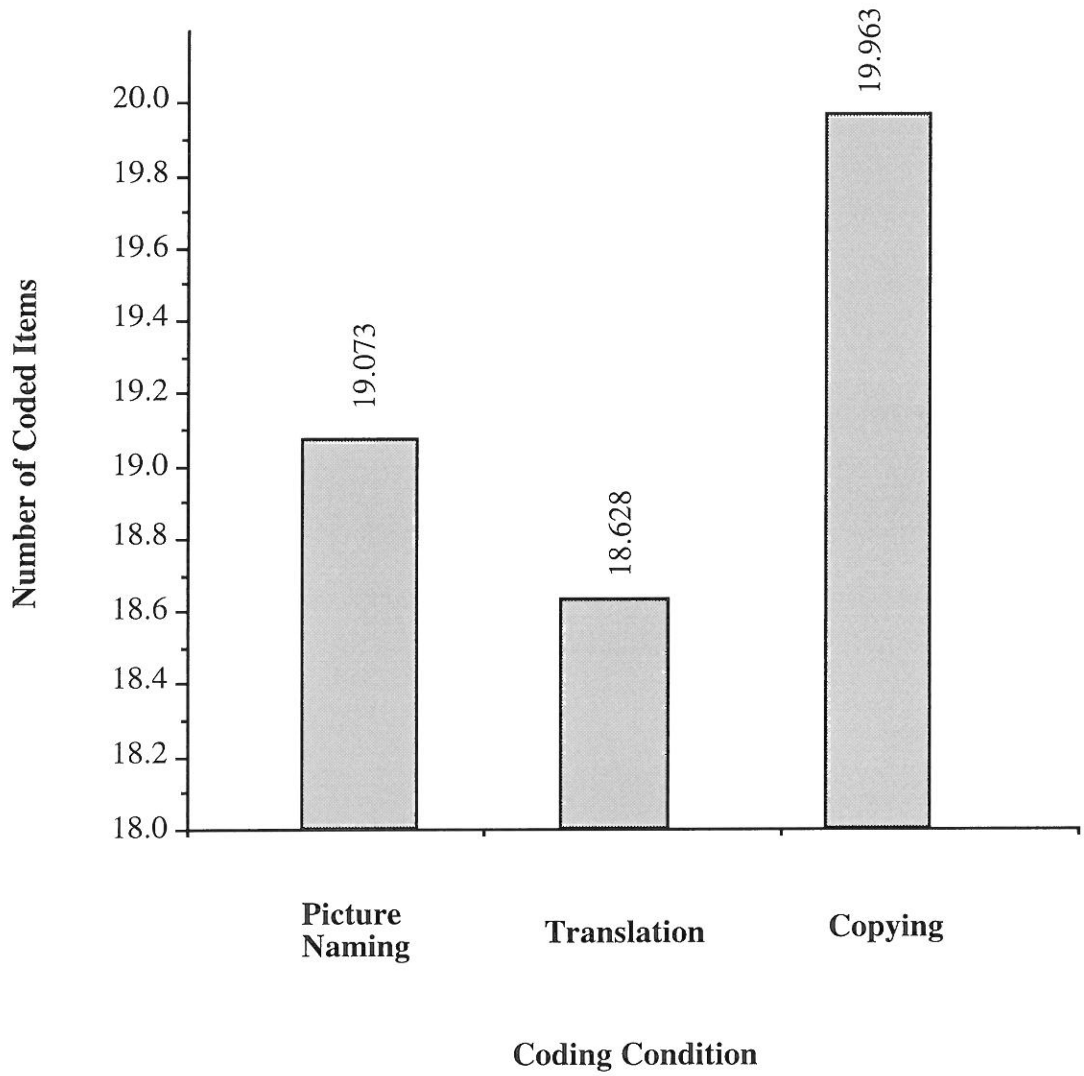


Overall, more items were coded in English than in Korean, but when the mean number of coded items in each language was examined by the three proficiency groups, it was evident that the opposite pattern of coding was noted in the Korean-dominant and English-dominant groups. That is, the Korean-dominant group coded more items in Korean (M = 29.7) than in English (M = 29.2), $t\ (71) = 3.003$, $p = .004$; while the English-dominant group coded more items in English (M = 28.5) than in Korean (M = 26.4), $t\ (54) = 6.343$, $p < .0001$. This interaction effect is shown in Figure A7-2. However, no significant difference in number of coded items was found between the two language codings for the Balanced group.

Figure A7-2 also depicts the difference in number of coded items between the three proficiency groups. In English coding, there was a significant difference in number of coded items between the proficiency groups, $F\ (2, 161) = 10.048$, $p < .0001$. Tukey's HSD multiple comparisons showed that there was a significant difference in number of coded items between the English-dominant and Korean-dominant groups, $p = .020$, and between the English-dominant and Balanced groups, $p < .0001$. The mean number of coded items for the English-dominant group (M = 28.5) was significantly lower than that of the Korean-dominant group (M = 29.2), $t\ (125) = 2.436$, $p = .016$, and the Balanced group (M = 29.8), $t\ (90) = 3.939$, $p < .0001$. There was also a noticeable difference in number of coded items between the Korean-dominant and Balanced groups, $p = .057$. In Korean coding, there was also a significant difference in number of coded items among the three proficiency groups, $F\ (2, 161) = 40.926$, $p < .0001$. Tukey's HSD multiple comparisons showed that there was a significant difference between the English-dominant group and the other two groups, $p < .0001$. The mean number of coded items for the English-dominant group (M = 26.4) was again significantly lower than that of the Korean-dominant group (M = 29.7), $t\ (125) = 8.231$, $p < .0001$, and the Balanced group (M = 29.6), $t\ (90) = 5.474$, $p < .0001$. However, no significant difference in number of coded items was noted between the Korean-dominant and Balanced groups.

The mean number of coded items was compared by coding condition. As can be seen in Figure A7-3, there was a significant difference in number of coded items by coding condition, $F\ (2, 326) = 40.452$, $p < .0001$. The mean number of coded items in the Picture-Naming condition was 19.1, and that of the Translation and Copying conditions was 18.6 and 19.96, respectively. Paired comparisons were next computed between the different coding conditions. A significant difference in number of coded items was found: between the Picture-Naming and Translation conditions, $t\ (163) = 3.160$, $p = .002$;

[Figure A7-3] Mean Difference in Number of Coded Items
by Coding Condition

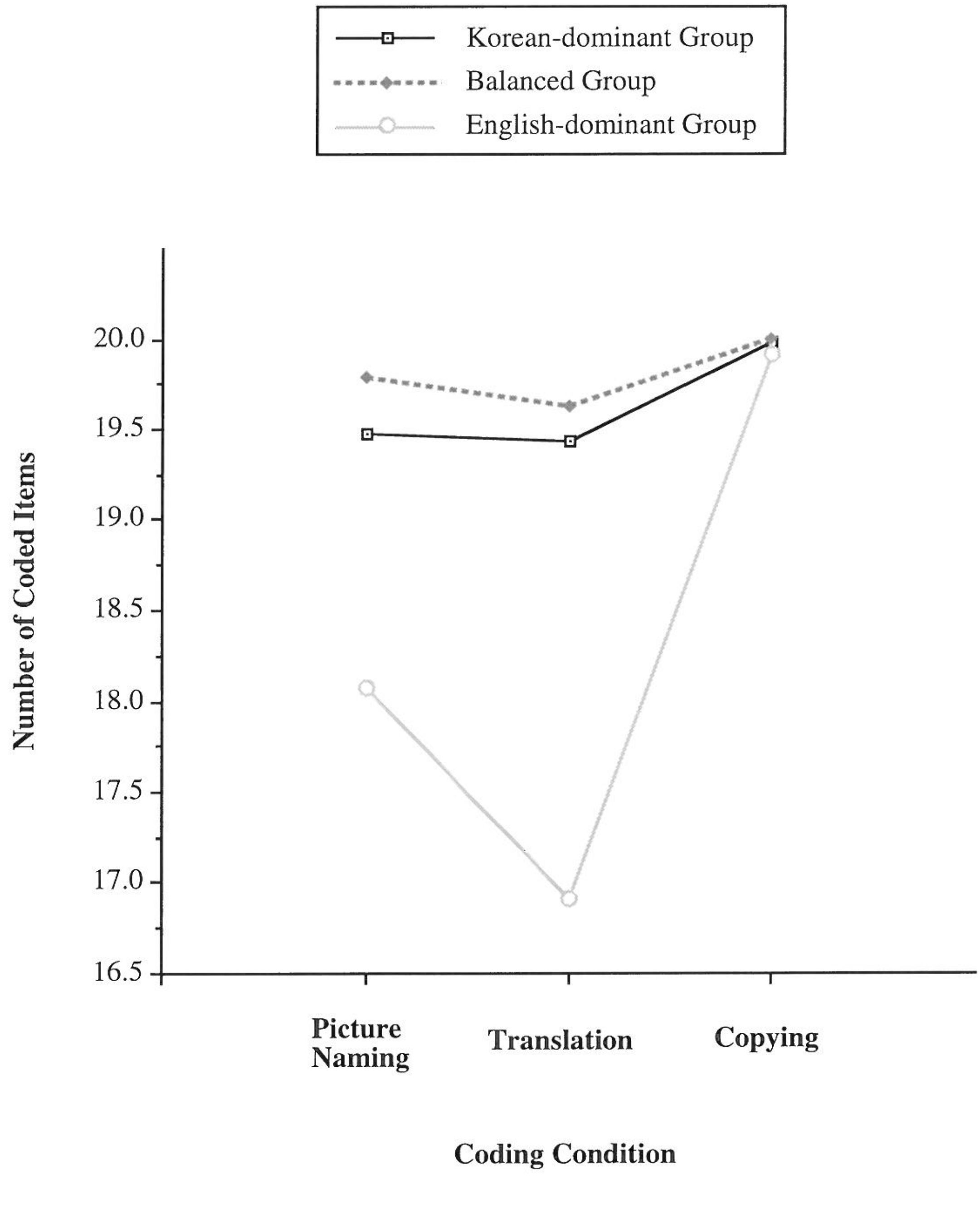


between the Picture-Naming and Copying conditions, t (163) = 7.964, $p < .0001$; and also between the Translation and Copying conditions, t (163) = 7.015, $p < .0001$.

In order to see the difference in number of coded items by coding condition with proficiency grouping, a two-way ANOVA was calculated. A significant interaction was found between coding condition and proficiency group, F (4, 322) = 18.957, $p < .0001$. This interaction effect is depicted in Figure A7-4. The mean difference in number of coded items between the three coding conditions was now examined for each of the three proficiency groups. For the Korean-dominant group, the mean number of coded items in the Copying condition (M = 19.99) was significantly higher than that of the Picture-Naming condition (M = 19. 5), t (71) = 5.670, $p < .0001$, and the Translation condition (M = 19.4), t (71) = 3.360, $p = .001$. However, no significant difference was noted between the Picture-Naming and Translation conditions. For the Balanced group, the mean difference in number of coded items was not found between any of the coding conditions. A somewhat different pattern of findings was observed for the English-dominant group as can be seen in Figure A7-4. The mean number of coded items in the Translation condition (M = 16.9) was significantly lower than that of both the Picture-Naming condition (M = 18.1), t (54) = 3.793, $p < .0001$, and the Copying condition (M = 19.9), t (54) = 7.478, $p < .0001$. Moreover, the mean number of coded items in the Picture-Naming condition was also significantly lower than that of the Copying condition, t (54) = 7.269, $p < .0001$.

The mean difference in number of coded items between the three proficiency groups was next examined for each of the three coding conditions, as can be also noted in Figure A7-4. In the Picture-Naming condition, a significant difference in number of coded items was found, F (2, 161) = 25.222, $p < .0001$. The mean number of coded items of the English-dominant group (M = 18.1) was significantly lower than that of the Korean-dominant group (M = 19.5), t (125) = 5.757, $p < .0001$, and Balanced group (M = 19.8), t (90) = 5.056, $p < .0001$. However, there was no significant difference between the Korean-dominant and Balanced groups. In the Translation condition, a significant difference in number of coded items was also found, F (2, 161) = 26.809, $p < .0001$. The mean number of coded items of the English-dominant group (M = 16.9) was again significantly lower than that of the Korean-dominant group (M = 19.4), t (125) = 6.342, $p < .0001$, and Balanced group (M = 19.6), t (90) = 4.944, $p < .0001$. However, there was no significant mean difference between the Korean-dominant and Balanced groups. In the Copying condition, no siginficant difference was found between the three proficiency groups. As can be seen in Figure A7-4, a significant interaction effect between the two

[Figure A7-4] Mean Difference in Number of Coded Items between Coding Conditions for Three Korean Proficiency Groups

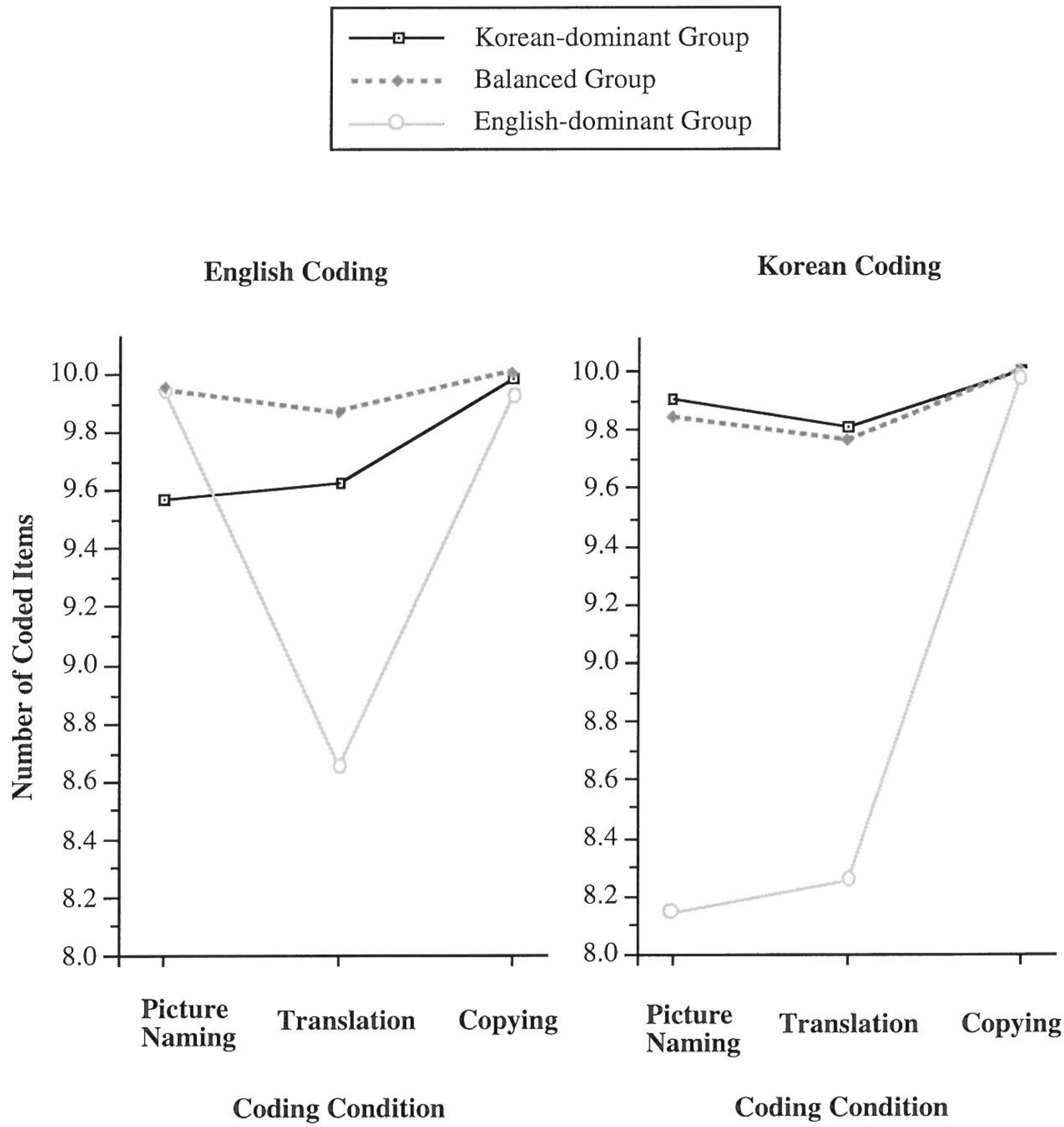


variables, coding condition and proficiency group, was due to the much fewer number of coded items in the Translation condition for the English-dominant group than the other groups, but recording the similar number of items in the Copying condition to the other groups.

In order to see the difference in number of coded items by all three variables: coding language, coding condition, and proficiency group, a three-way ANOVA was performed. The results showed that there was a significant between-group difference in number of coded items by proficiency group, $F(2, 161) = 32.454$, $p < .0001$. There was also a significant within-group difference by coding language, $F(1, 161) = 16.288$, $p < .0001$, and by coding condition, $F(2, 322) = 43.944$, $p < .0001$. A significant interaction was noted: between coding language and proficiency group, $F(2, 161) = 32.405$, $p < .0001$; and also between coding condition and proficiency group, $F(4, 322) = 18.957$, $p < .0001$. Moreover, a significant interaction was found between coding language and coding condition, $F(2, 322) = 12.596$, $p < .0001$, and there was even a significant interaction involving all three variables, $F(4, 322) = 20.973$, $p < .0001$.

In English coding, there was a significant difference in number of coded items by proficiency group, $F(2, 161) = 10.048$, $p < .0001$. There was also a significant difference in number of coded items by coding condition, $F(2, 322) = 30.399$, $p < .0001$. Moreover, a significant interaction between coding condition and proficiency group was also noted, $F(4, 322) = 18.784$, $p < .0001$ (see Figure A7-5). The mean difference between the three coding conditions in English was examined for each of the three proficiency groups. For the Korean-dominant group, there was a significant difference in number of coded items between the coding conditions, $F(2, 142) = 11.725$, $p < .0001$. The mean number of coded items in the Copying condition ($M = 9.99$) was significantly higher than that of the Picture-Naming condition ($M = 9.57$), $t(71) = 5.147$, $p < .0001$ and the Translation condition, ($M = 9.63$), $t(71) = 4.155$, $p < .0001$, but no significant difference was noted between the Picture-Naming and Translation conditions. For the Balanced group, there was no significant difference between the coding conditions. However, for the English-dominant group, there was a significant difference in number of coded items between the coding conditions, $F(2, 108) = 34.463$, $p < .0001$. The mean number of the Translation condition ($M = 8.66$) was significantly lower than that of the Picture-Naming condition, ($M = 9.95$), $t(54) = 5.960$, $p < .0001$ and Copying condition ($M = 9.93$), $t(54) = 5.802$, $p < .0001$. No significant difference in number of coded items was noted between the Picture-Naming and Copying conditions.

[Figure A7-5] Mean Difference in Number of Coded Items by Coding Language, Proficiency Group, and Coding Condition



The mean difference between the three proficiency groups in English coding was also examined for each of the three coding conditions. In the Picture-Naming condition, there was a significant difference in number of coded items between the proficiency groups, $F(2, 161) = 9.922$, $p < .0001$. The mean numer of coded items for the Korean-dominant group ($M = 9.57$) was significantly lower than that of the Balanced group ($M = 9.95$), $t(107) = 3.142$, $p = .002$, and the English-dominant group ($M = 9.95$), $t(125) = 3.519$, $p = .001$, but no difference was noted between the Balanced and English-dominant groups. In the Translation condition, there was also a significant difference in number of coded items between the proficiency groups, $F(2, 161) = 17.399$, $p < .0001$. The mean number of coded items for the English-dominant group ($M = 8.66$) was significantly lower than that of the Korean-dominant group ($M = 9.63$), $t(125) = 4.550$, $p < .0001$, and the Balanced group ($M = 9.87$), $t(90) = 4.313$, $p < .0001$, but no significant difference was noted between the Korean-dominant and Balanced groups. In the Copying condition, there was no significant difference between the three proficiency groups. As can be noted in Figure A7-5, a significant interaction effect came from the fact that the English-dominant group coded fewer items in the Translation condition than did the other two groups, while also recording a higher number of items than the Korean-dominant group in the Picture-Naming condition, and a similar number of items to the other groups in the Copying condition.

In Korean coding, there was a significant difference in number of coded items by proficiency group, $F(2, 161) = 40.926$, $p < .0001$. There was also a significant difference in number of coded items by coding condition, $F(2, 322) = 32.137$, $p < .0001$. Moreover, a significant interaction between coding condition and proficiency group was also found, $F(4, 322) = 20.327$, $p < .0001$ (see also Figure A7-5). The mean difference between the three coding conditions in Korean coding was examined for each of the three proficiency groups. The significant difference in number of coded items between the coding conditions was found only for the English-dominant group, $F(2, 108) = 37.072$, $p < .0001$. The mean number of the Copying condition ($M = 9.98$) was significantly higher than that of the Picture-Naming condition ($M = 8.13$), $t(54) = 7.434$, $p < .0001$, and the Translation condition ($N = 8.26$), $t(54) = 7.243$, $p < .0001$. No significant difference was noted between the Picture-Naming and Translation conditions.

The mean difference between the three proficiency groups in Korean coding was also examined for each of the three coding conditions (see also Figure A7-5). In the Picture-Naming condition, there was a significant difference in number of coded items

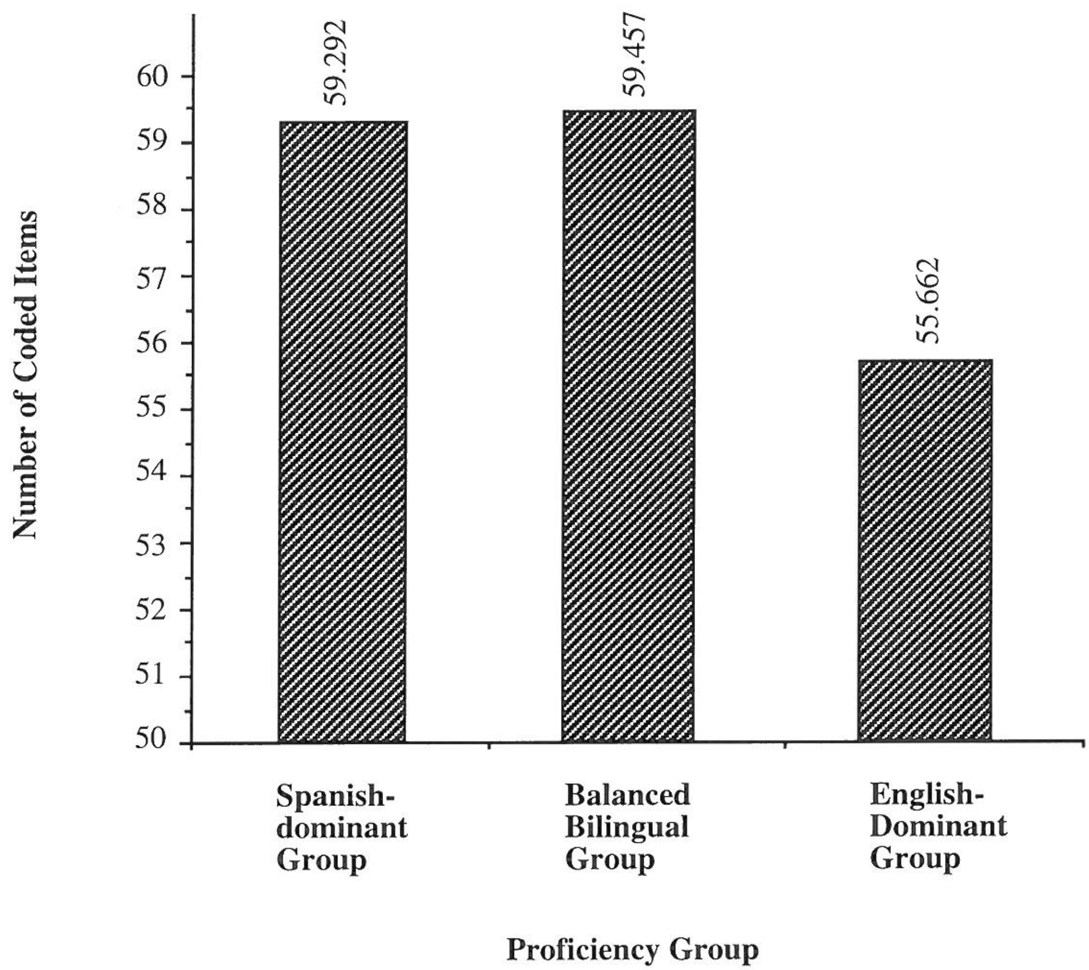
between the proficiency groups, F (2, 161) = 41. 645, $p < .0001$. The mean numer of coded items for the English-dominant group (M = 8.13) was significantly lower than that of the Korean-dominant group (M = 9.90), t (125) = 7.991, $p < .0001$, and the Balanced group (M = 9.84), t (90) = 5.253, $p < .0001$. However, no significant difference was noted between the Korean-dominant and Balanced groups. In the Translation condition, there was also a significant difference in number of coded items between the three proficiency groups, F (2, 161) = 22.918, $p < .0001$. The mean number of coded items for the English-dominant group (M = 8.26) was significantly lower than that of both the Korean-dominant group (M = 9.81), t (125) = 6.103, $p < .0001$, and the Balanced group (M = 9.76), t (90) = 4.527, $p < .0001$. No significant difference, however, was found between the Korean-dominant and Balanced groups. In the Copying condition, there was no significant difference in number of coded items between the three proficiency groups. A significant interaction effect, as can be noted in Figure A7-5, came from the fact that the English-dominant group coded fewer items in the Picture-Naming and Translation conditions than the other groups, while recording a similar number of items to the other groups in the Copying condition.

There was no gender difference in number of coded items and no significant interaction effect was found between gender and any of the major three factors: coding language, proficiency group, and coding condition. Since half of the subjects were asked to code (write down) the stimulus item first in English, then in Korean, and the rest of the subjects coded the item first in Korean, then in English, the order of the coding language effect was examined. There was no significant difference in number of coded items by the order of the coding language and no significant interaction between the order of the coding language and the other three major factors. Moreover, no interaction between gender and the order of the coding language was found.

Spanish-English Bilingual Data

There was a significant difference in total number of coded items in Task 1 (Coding Task) between the three different proficiency groups, F (2, 173) = 42.675, $p < .0001$, (see Figure A7-6). Tukey's HSD multiple comparisons showed that a significant difference in number of coded items was found between the English-dominant group and the other two groups, $p < .0001$. The English-dominant group (M = 55.7) had significantly fewer items coded than both the Spanish-dominant group (M = 59.3), t (93) = 4.578, $p < .0001$, and the Balanced group (M = 59.5), t (150) = 8.315, $p < .0001$, but no difference was found

[Figure A7-6] Total Mean Difference in Number of Coded Items for the Three Spanish Proficiency Groups

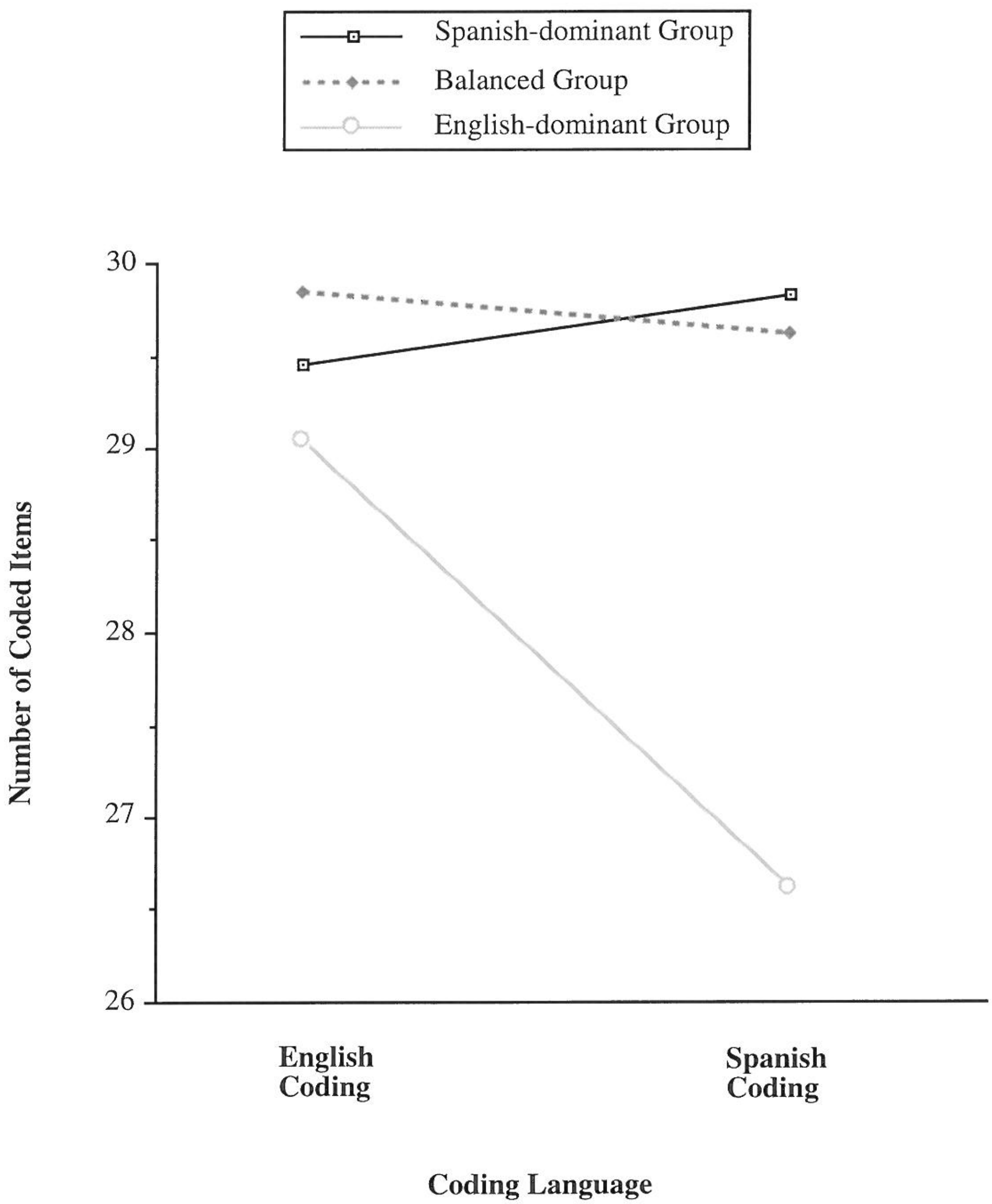


between the Spanish-dominant and Balanced groups. A significant difference in number of coded items was also noted between English coding (M = 29.5) and Spanish coding (M = 28.4), t (175) = 6.927, $p < .0001$. However, the pattern of the difference in number of coded items between the two language codings differed according to the subject's proficiency group. A two-way ANOVA for coding language and proficiency group revealed not only a significant difference in number of coded items by coding language and by proficiency group, but also a significant interaction between coding language and proficiency group, F (2, 173) = 46.670, $p < .0001$.

Overall, more items were coded in English than in Spanish, but when the mean number of coded items in each language was examined by the three proficiency groups, it was evident that the opposite pattern of coding was noted in the Spanish-dominant and English-dominant groups. That is, the Spanish-dominant group coded more items in Spanish, while the English-dominant group coded more items in English. This interaction effect is shown in Figure A7-7. No significant difference in number of coded items was found between the two language codings for the Spanish-dominant and Balanced groups. However, for the English-dominant group, the mean number of English-coded items (M = 29.0) was significantly higher than Spanish-coded items (M = 26.6), t (70) = 9.138, $p < .0001$.

Figure A7-7 also depicts the difference in number of coded items between the three proficiency groups. In English coding, there was a significant difference in number of coded items between the proficiency groups, F (2, 173) = 14.081, $p < .0001$. Tukey's HSD multiple comparisons showed that the only significant difference was found between the Balanced and English-dominant groups, $p < .0001$. The mean number of coded items for the Balanced group (M = 29.8) was significantly higher than that of the English-dominant group (M = 29.0), t (150) = 5.398, $p < .0001$. In Spanish coding, there was also a significant difference in number of coded items among the three proficiency groups, F (2, 173) = 50.192, $p < .0001$. Tukey's HSD multiple comparisons showed that a significant difference was found between the English-dominant group and the other two groups. The mean number of coded items for the English-dominant group (M = 26.6) was significantly lower than that of the Spanish-dominant group (M = 29.8), t (150) = 8.686, $p < .0001$, and the Balanced group (M = 29.6), t (93) = 5.412, $p < .0001$. However, no significant difference was found between the Spanish-domiant and Balanced groups.

[Figure A7-7] Mean Difference in Number of Coded Items for the Three Spanish Proficiency Groups by Coding Language

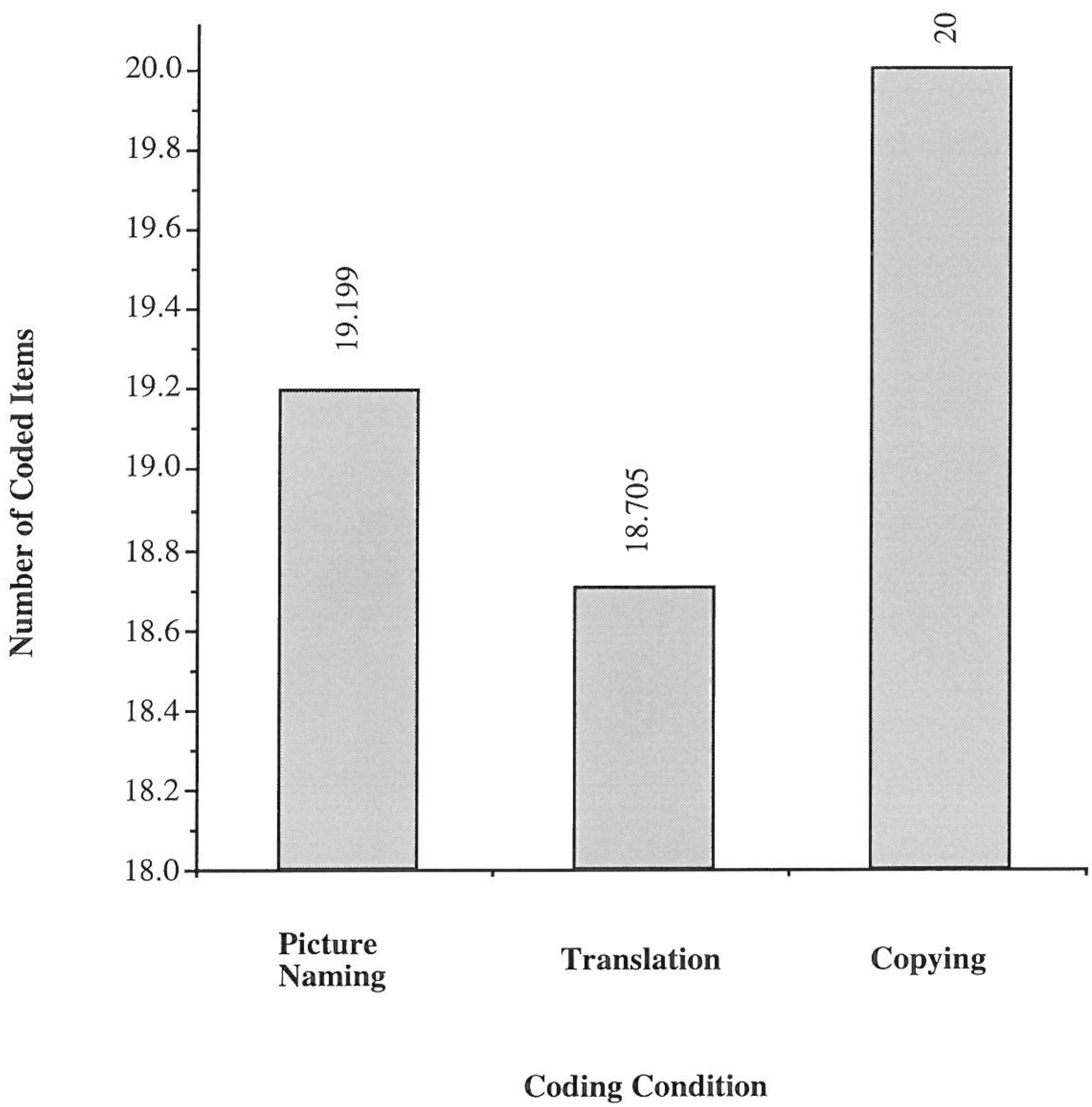


The mean number of coded items was compared by coding condition. As can be seen in Figure A7-8, there was a significant difference in number of coded items by coding condition. However, it was not possible to compute an ANOVA on the number of coded items since there was no variance in one of the dependent variable, the Copying condition. Instead, paired comparisons were computed between the different coding conditions, using t-tests. The mean number of coded items in the Copying condition ($M = 20.00$) was significantly higher than that of the Picture-Naming condition ($M = 19.20$), $t(175) = 7.811$, $p < .0001$, and the Translation condition ($M = 18.71$), $t(175) = 8.222$, $p < .0001$. The mean number of the Picture-Naming condition was also significantly higher than that of the Translation condition, $t(175) = 4.535$, $p < .0001$.

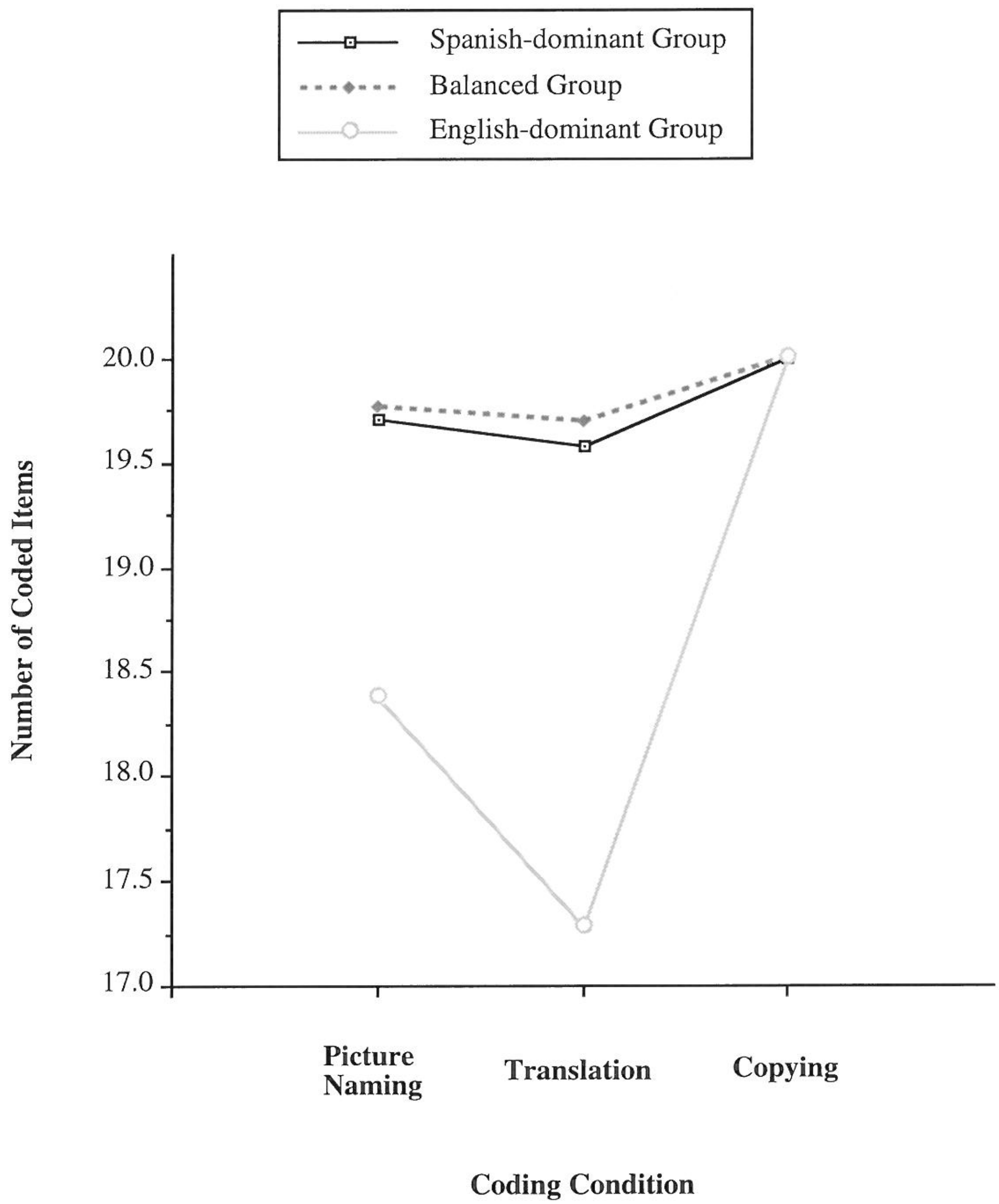
In order to see the difference in number of coded items by coding condition with proficiency grouping, a two-way ANOVA was calculated. A significant interaction was found between coding condition and proficiency group, $F(4, 346) = 28.917$, $p < .0001$. This interaction effect is depicted in Figure A7-9. The mean difference in number of coded items between the three coding conditions was now examined for each of the three proficiency groups. For the Spanish-dominant group, the mean number of coded items in the Copying condition ($M = 20$) was significantly higher than that of the Picture-Naming condition ($M = 19.7$), $t(23) = 2.290$, $p = .032$, and the Translation condition ($M = 19.6$), $t(23) = 2.846$, $p = .009$. However, no significant difference in number of coded items was found between the Picture-Naming and Translation conditions. For the Balanced group, the mean number of coded items in the Copying condition ($M = 20$) was also significantly higher than that of the Picture-Naming condition ($M = 19.8$), $t(80) = 2.965$, $p = .004$, and the Translation condition ($M = 19.7$), $t(80) = 3.174$, $p = .002$. No significant difference, however, was found between the Picture-Naming and Translation conditions. For the English-dominant group, as can be noted in Figure A7-9, a different pattern of coding was observed from the other two groups. The mean number of coded items in the Translation condition ($M = 17.3$) was significantly lower than that of both the Picture-Naming condition ($M = 18.4$), $t(70) = 4.693$, $p < .0001$, and the Copying condition ($M = 20$), $t(70) = 9.03$, $p < .0001$. Moreover, the mean number of coded items in the Picture-Naming condition was also significantly lower than that of the Copying condition, $t(70) = 8.183$, $p < .0001$.

The mean difference in number of coded items between the three proficiency groups was next examined for each of the three coding conditions, as can be also noted in Figure A7-9. In the Picture-Naming condition, a significant difference in number of coded items

[Figure A7-8] Mean Difference in Number of Coded Items
by Coding Condition



[Figure A7-9] Mean Difference in Number of Coded Items between Coding Conditions for Three Spanish Proficiency Groups

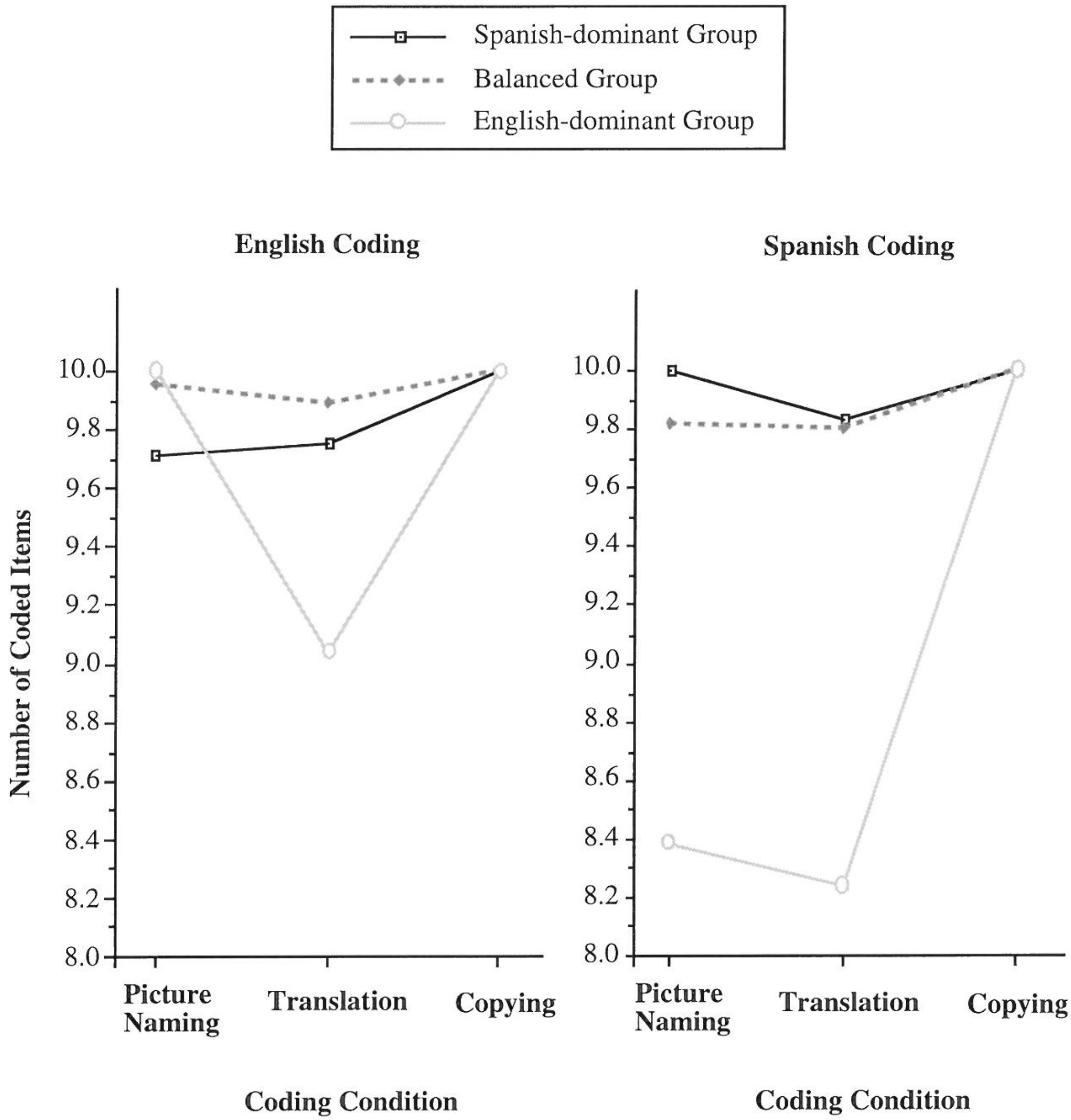


was found, $F(2, 173) = 28.265$, $p < .0001$. The mean number of coded items for the English-dominant group ($M = 18.4$) was significantly lower than that of the Balanced group ($M = 19.8$), $t(150) = 6.803$, $p < .0001$, and the Spanish-dominant group ($M = 19.7$), $t(93) = 3.801$, $p < .0001$. However, no significant difference was found between the Spanish-dominant and Balanced groups. In the Translation condition, a significant difference in number of coded items was also found, $F(2, 173) = 39.848$, $p < .0001$. The mean number of coded items of the English-dominant group ($M = 17.3$) was significantly lower than that of the Balanced group ($M = 19.7$), $t(150) = 8.025$, $p < .0001$, and the Spanish-dominant group ($M = 19.6$), $t(93) = 4.373$, $p < .0001$. No significant difference, however, was found between the Spanish-dominant and Balanced groups. In the Copying condition, every item was coded for all three proficiency groups. As can be noted in Figure A7-9, a significant interaction effect between the two variables, coding condition and proficiency group, was due to the much fewer number of coded items in the Translation condition for the English-dominant group than the other groups, but recording the same number of items in the Copying condition as the other groups.

In order to see the difference in number of coded items by all three variables: coding language, coding condition, and proficiency group, a three-way ANOVA was performed. The results showed that there was a significant between-group difference in number of coded items by proficiency group, $F(2, 173) = 39.870$, $p < .0001$. There was also a significant within-group difference by coding language, $F(1, 173) = 17.879$, $p < .0001$, and by coding condition, $F(2, 346) = 30.960$, $p < .0001$. A significant interaction was also noted: between coding language and proficiency group, $F(2, 173) = 28.112$, $p < .0001$; and also between coding condition and proficiency group, $F(4, 346) = 21.170$, $p < .0001$. Moreover, a significant interaction was found between coding language and coding condition, $F(2, 346) = 6.409$, $p = .002$, and there was even a significant interaction involving all three variables, $F(4, 346) = 11.109$, $p < .0001$.

In English coding, there was a significant difference in number of coded items by proficiency group, $F(2, 173) = 14.081$, $p < .0001$. There was also a significant difference in number of coded items by coding condition, $F(2, 346) = 26.789$, $p < .0001$. Moreover, a significant interaction between coding condition and proficiency group was also noted, $F(4, 346) = 21.429$, $p < .0001$ (see Figures A7-10). The mean difference between the three coding conditions in English was examined for each of the three proficiency groups. For the Spanish-dominant group, the mean number of coded items in the Copying condition ($M = 10$) was significantly higher than that of the Picture-Naming

[Figure A7-10] Mean Difference in Number of Coded Items by Coding Language, Proficiency Group, and Coding Condition



condition (M = 9.71), t (23) = 2.290, p = .032, and the Translation condition (M =9.75), t (23) = 2.304, p = .031, but there was no significant difference between the Picture-Naming and Translation conditions. For the Balanced group, the mean number of coded items in the Copying condition (M = 10) was also significantly higher than that of the Picture-Naming condition (M = 9.95), t (80) = 2.039, p = .045, and the Translation condition (M = 9.89), t (80) = 2.000, p = .049, but no significant difference was noted between the Picture-Naming and Translation conditions. For the English-dominant group, the mean number of the Translation condition (M = 9.04) was significantly lower than that of the Picture-Naming and Copying conditions (for both, M = 10), t (70) = 6.790, $p <$ .0001.

The mean difference between the three proficiency groups in English coding was also examined for each of the three coding conditions. In the Picture-Naming condition, there was a significant difference in number of coded items between the proficiency groups, F (2, 173) = 10.518, $p < .0001$. The mean numer of coded items for the Spanish-dominant group (M = 9.71) was significantly lower than that of the Balanced group (M = 9.95), t (103) = 2.962, p = .004, and the English-dominant group (M = 10). However, there was no significant difference between the Balanced and English-dominant groups. In the Translation condition, there was also a significant difference in number of coded items between the proficiency groups, F (2, 173) = 19.653, $p < .0001$. The mean number of coded items for the English-dominant group (M = 9.04) was significantly lower than that of the Spanish-dominant group (M = 9.75), t (93) = 2.816, p = .006, and the Balanced group (M = 9.89), t (150) = 5.850, $p < .0001$, but no significant difference was noted between the Spanish-dominant and Balanced groups. In the Copying condition, there was no comparison computed because every items was coded for all three proficiency groups. As can be noted in Figure 5-1-10, a significant interaction effect came from the English-dominant group's fewer number of coded items in the Translation condition than the other two groups, while recording higher number of items in the Picture-Naming condition than the Spanish-dominant group.

In Spanish coding, there was a significant difference in number of coded items by proficiency group, F (2, 173) = 50.192, $p < .0001$. There was also a significant difference in number of coded items by coding condition, F (2, 346) = 28.059, $p < .0001$. Moreover, a significant interaction was also found between coding condition and proficiency group, F (4, 346) = 24.055, $p < .0001$, (see also Figure A7-10). The mean difference between the three coding conditions in Spanish coding was examined for each of

the three proficiency groups. For the Spanish-dominant group, the mean number of coded items in the Translation condition (M = 9.83) was significantly fewer than that of both the Picture-Naming and the Copying conditions (for both, M = 10), t (23) = 2.214, p = .043. For the Balanced group, the mean number of coded items in the Copying condition (M = 10) was significantly higher than that of the Picture-Naming condition (M = 9.82), t (80) = 2.548, p = .013, and the Translation condition (M = 9.80), t (80) = 3.483, p = .001, but no significant difference was noted between the Picture-Naming and Translation conditions. For the English-dominant group, the mean number of the Copying condition (M = 10) was also significantly higher than that of the Picture-Naming condition (M = 8.38), t (70) = 8.183, $p < .0001$, and the Translation condition (M = 8.24), t (70) = 8.546, $p < .0001$. No significant difference was noted between the Picture-Naming and Translation conditions.

The mean difference between the three proficiency groups in Spanish coding was also examined for each of the three coding conditions (see also Figure A7-10). In the Picture-Naming condition, there was a significant difference in number of coded items between the proficiency groups, F (2, 173) = 35.144, $p < .0001$. The mean numer of coded items for the English-dominant group (M = 8.38) was significantly lower than that of the Spanish-dominant group (M = 10) and the Balanced group (M = 9.82), t (150) = 7.142, $p < .0001$. No significant difference was noted between the Spanish-dominant and Balanced groups. In the Translation condition, there was a significant difference in number of coded items between the proficiency groups, F (2, 173) = 38.425, $p < .0001$. The mean number of coded items for the English-dominant group (M = 8.24) was significantly lower than that of the Spanish-dominant group (M = 9.83), t (93) = 4.45, $p < .0001$, and the Balanced group (M = 9.80), t (150) = 7.74, $p < .0001$, but no significant difference was found between the Spanish-dominant and Balanced groups. In the Copying condition, there was no comparison computed because every items was coded for all three proficiency groups. A significant interaction effect, as can be noted in Figure 5-1-10, came from the fact that the English-dominant group coded fewer items in the Picture-Naming and Translation conditions than the other groups, while recording a same number of items as the other groups in the Copying condition.

There was no gender difference in number of coded items and no significant interaction effect was found between gender and any of the major three factors: coding language, proficiency group, and coding condition. Since half of the subjects were asked to code the stimulus item first in English, then in Spanish, and the rest of the subjects coded the item first in Spanish, then in English, the order of the coding language effect was

examined. There was no singificant difference in number of coded items by the order of the coding language and no significant interaction between the order of the coding language and the other three major factors. Moreover, no interaction between gender and the order of the coding language was found.

Comparisons of Korean-English and Spanish-English bilingual data. There was no significant difference in number of coded items between the Korean-English bilingual group and the Spanish-English bilingual group. Moreover, no significant interaction was found between the bilingual language group and any of the major variables: proficiency group, coding language, coding condition. Actually, the coding patterns in the two bilingual language groups were strikingly similar to each other.

APPENDIX 8

Analysis and Results of Task 3 (Recognition Task)

in Bilingual Memory Study (Study III)

Analysis and Results of Task 3 (Recognition Task)

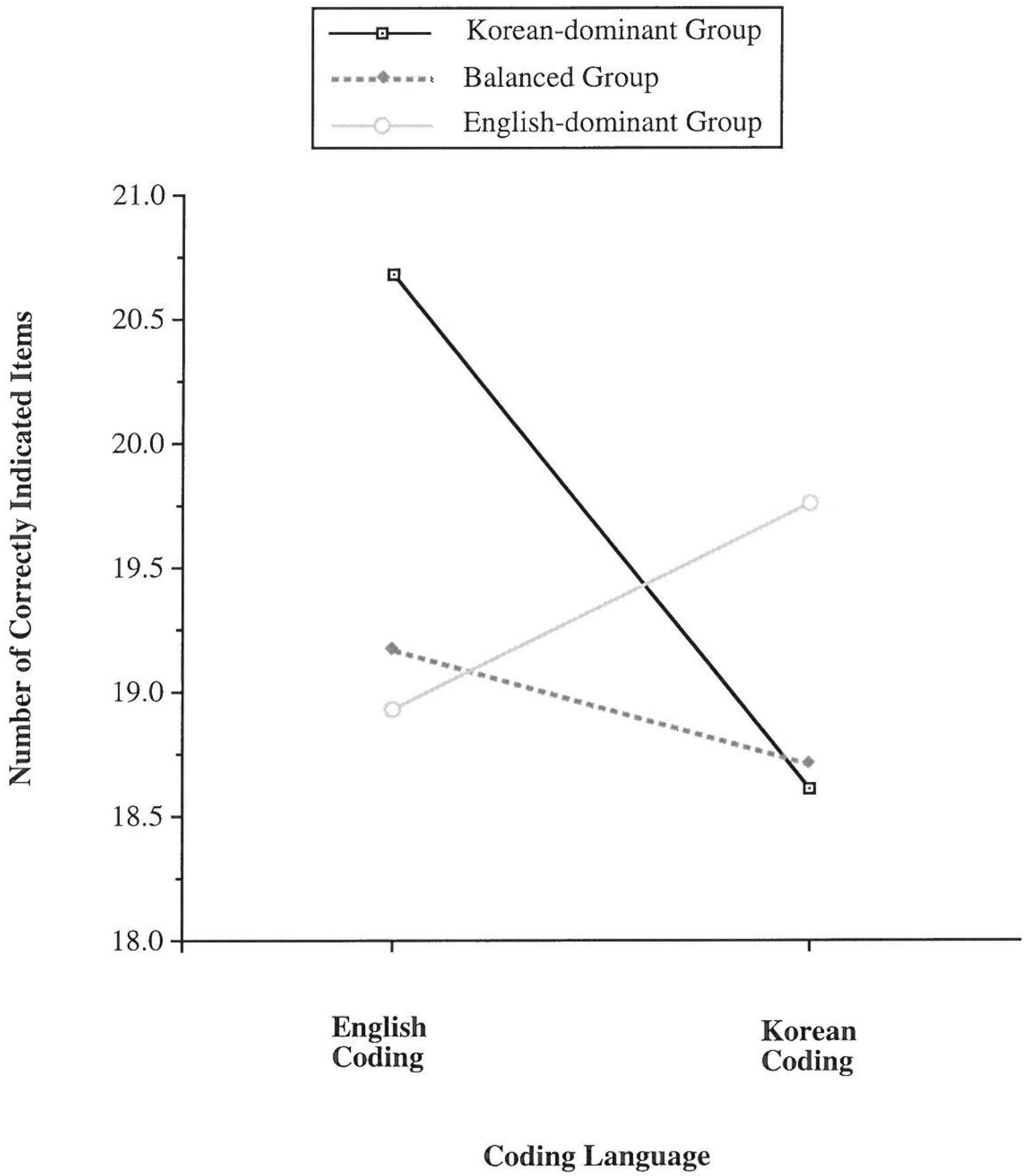
In Task 3, subjects were asked to recognize the mode of each item presented in Task 1. The number of items whose presenting mode was correctly recognized was analyzed based on proficiency group, coding condition, and coding language. Recognition data for each of the two bilingual groups (Korean-English and Spanish-English bilingual groups) was first analyzed separately, then compared between the two groups.

Korean-English Bilingual Data

There was no significant difference in total number of correctly recognized items between the three proficiency groups. There was no significant difference in number of correctly recognized items between English (M = 19.76) and Korean (M = 19.03), p = .089. However, as can be seen in Figure A8-1, the pattern of the number of correctly recognized items in the two languages was significantly different for the three proficiency groups. A two-way ANOVA for coding language and proficiency group revealed that there was a significant interaction between coding language and proficiency group, $F(2, 159) = 8.274$, $p < .0001$.

The difference in number of correctly recognized items was examined between English and Korean for each of the proficiency groups (see Figure A8-1). For the Korean-dominant group, the mean number of correctly recognized items in English (M = 20.68) was significantly higher than Korean items (M = 18.61), $t(71) = 4.706$, $p < .0001$. No difference was noted between the two languages for the Balanced group. For the English-dominant group, more items were correctly recognized in Korean (M = 19.76) than in English (M = 18.93), but the difference was not significant, $p = .147$. The number of correctly recognized items between the proficiency groups was also examined in each of the languages. In English, the difference in number of correctly recognized items between the proficiency groups did not attain statistical significance, $p = .076$. As can be seen in Figure A8-1, the difference between the Korean-dominant group (M = 20.68) and English-dominant group (M = 18.93) was noticeable, but not significant, $p = .085$. There was no other significant difference found. In Korean, no significant difference in number of correctly recognized items was found between the three proficiency groups.

[Figure A8-1] Mean Difference in Number of Correctly Recognized Items for the Three Korean Proficiency Groups by Coding Language



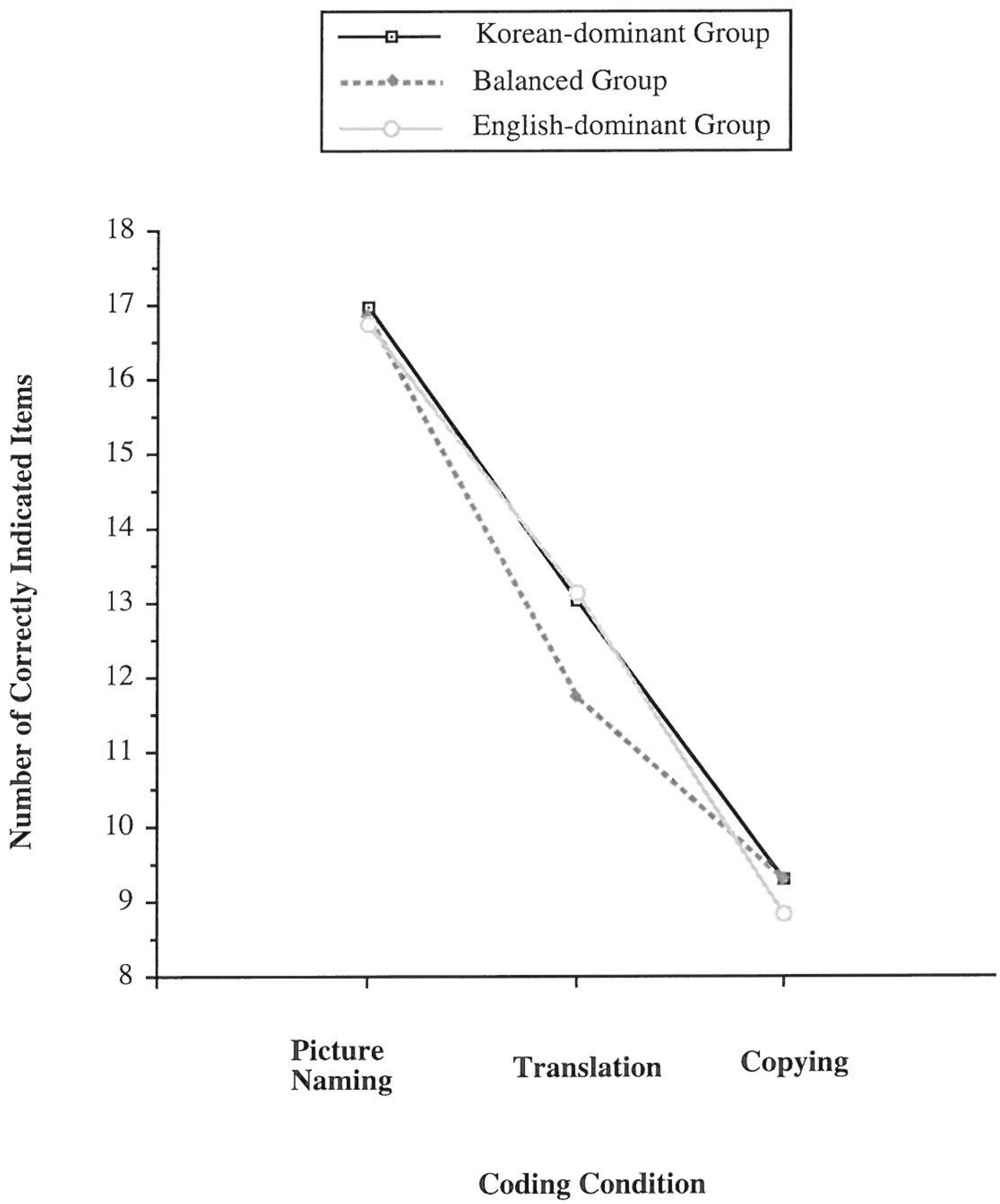
The mean number of correctly recognized items was examined by coding condition. There was a significant difference in number of correctly recognized items between the three coding conditions, F (2, 322) = 258.136, $p < .0001$. The mean number of correctly recognized items in the Picture-Naming condition (M = 16.85) was significantly higher than that of the Translation condition (M = 12.79), t (161) = 12.635, $p < .0001$, and the Copying condition (M = 9.14), t (161) = 22.896, $p < .0001$. There was also a significant difference between the Translation and Copying conditions, t (161) = 10.157, $p < .0001$. In order to see the difference in number of correctly recognized items by coding condition and proficiency group, a two-way ANOVA was calculated, but no significant interaction effect was found. It means that the same coding language difference was uniformly found in the three proficiency groups (see Figure A8-2).

In order to see the difference in number of correctly recognized items across all three variables: coding language, proficiency group, and coding condition, a three-way ANOVA was performed. Other than a significant interaction between coding language and proficiency group and a significant difference by coding condition, there was a significant interaction between coding language and coding condition, F (2, 318) = 13.840, $p < .0001$. Moreover, a significant three-way interaction across all three variables was also found, F (4, 318) = 18.945, $p < .0001$.

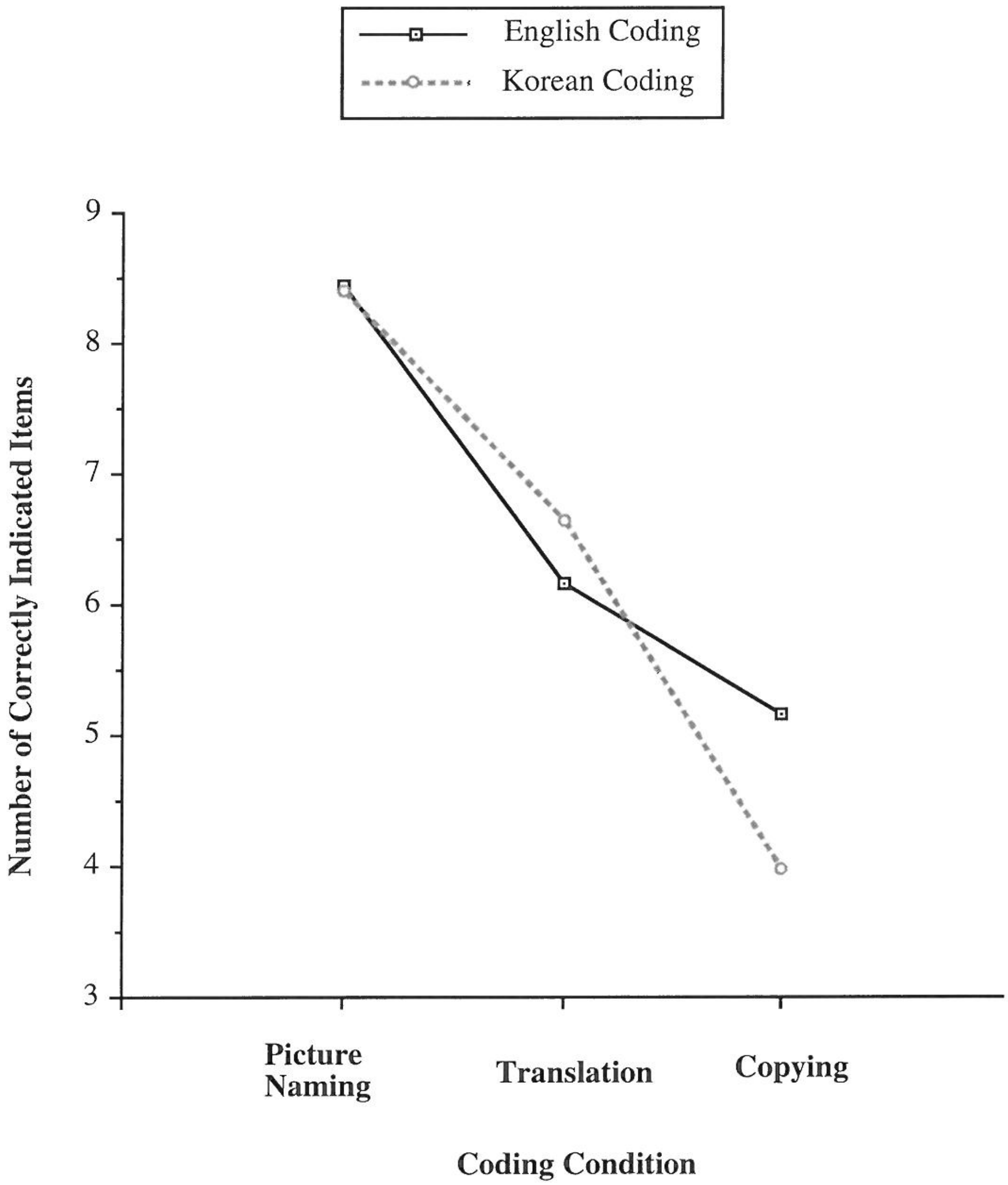
A significant interaction effect between coding language and coding condition in number of correctly recognized items was first examined. As can be seen in Figure A8-3, the number of correctly recognized items in English (M = 6.15) in the Translation condition was significantly lower than Korean items (M = 6.64), t (161) = 2.267, $p = .025$. However, on the contrary, the number of correctly recognized items in English (M = 5.16) in the Copying condition was significantly higher than the Korean items (M = 3.98), t (161) = 4.586, $p < .0001$. There was no difference in number of correctly recognized items between the two language codings in the Picture-Naming condition.

A significant three-way interaction by coding language, proficiency group, and coding condition was next examined. As can be noted in Figure A8-4, in English coding, the pattern of number of correctly recognized items in the three coding conditions was similar for the Korean-dominant and Balanced groups but that of the English-dominant group was very different from the other two groups. The mean number of correctly recognized items for the English-dominant group (M = 6.84) in the Translation condition

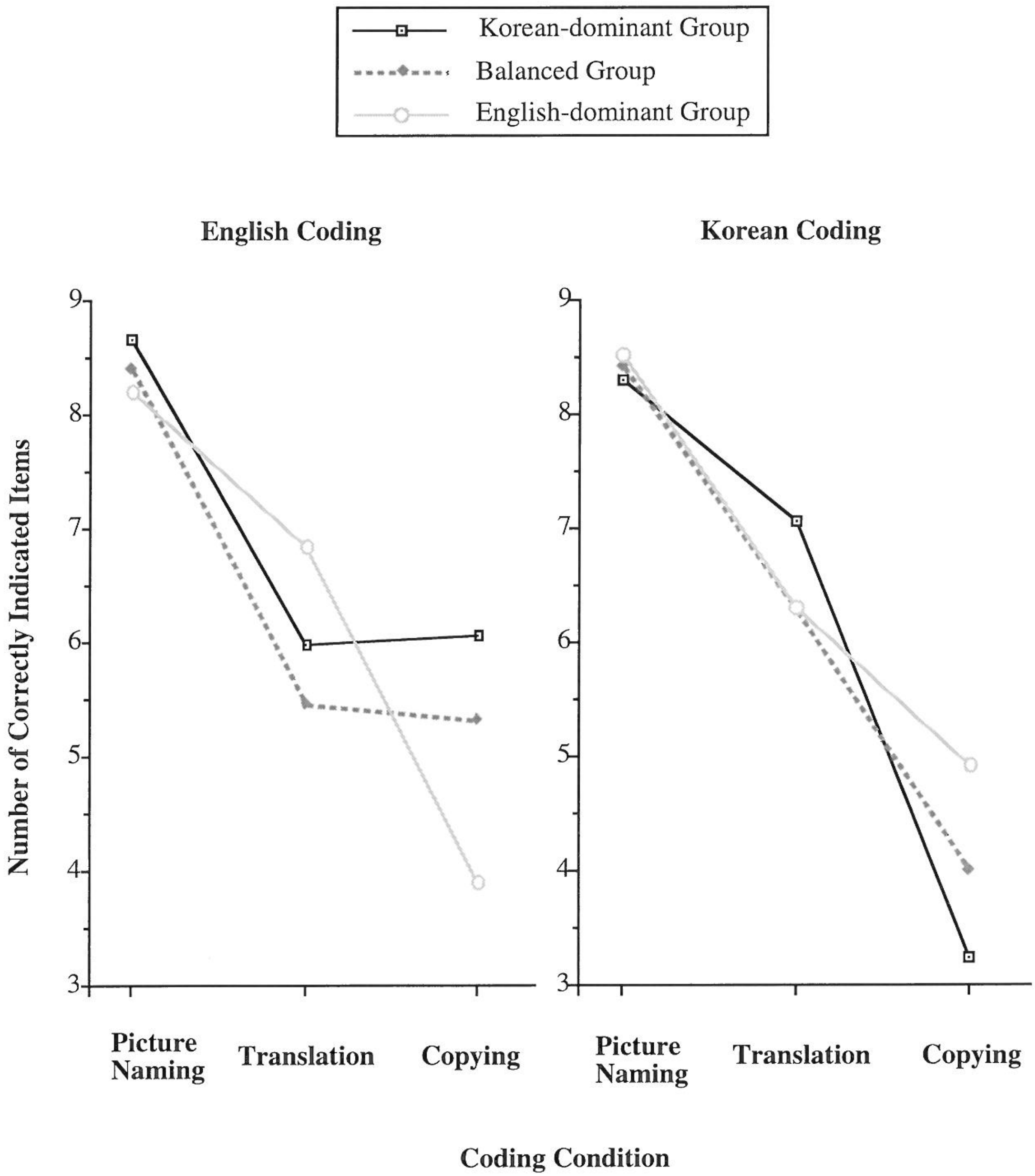
[Figure A8-2] Mean Difference in Number of Correctly Recognized Items for the Three Korean Proficiency Groups by Coding Condition



[Figure A8-3] Mean Difference in Number of Correctly Recognized Items by Coding Condition in Two Language Codings



[Figure A8-4] Mean Difference in Number of Correctly Recognized Items by Coding Condition and Proficiency Group in Two Language Codings



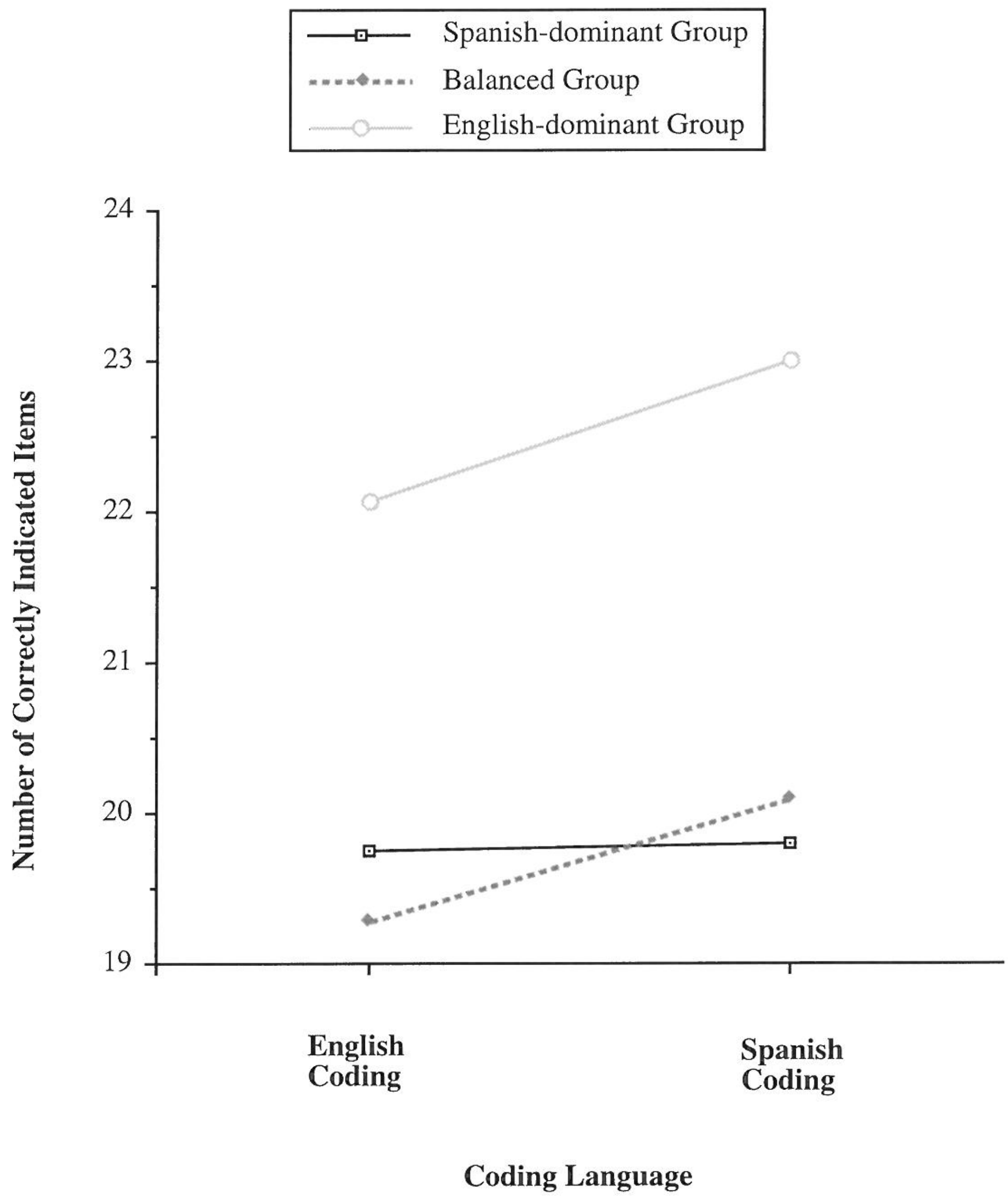
was significantly higher than that of the Balanced group (M = 5.46), t (88) = 2.608, p = .011. However, the mean number of correctly recognized items for the English-dominant group (M = 3.89) in the Copying condition was significantly lower than that of the Korean-dominant group (M = 6.06), t (125) = 4.931, $p < .0001$, and the Balanced group (M = 5.31), t (88) = 2.928, $p = .004$.

On the other hand, in Korean coding, a different finding was noted (see also Figure A8-4). The pattern of number of correctly recognized items in the three coding conditions for the Korean-dominant group was significantly different from the other groups. The mean number of correctly recognized items for the Korean-dominant group in the Translation condition was higher than that of the other two groups while the Korean-dominant group's number of correctly recognized items (M = 3.25) in the Copying condition was significantly lower than that of the English-dominant group (M = 4.93), t (125) = 3.589, $p < .0001$. There was no gender difference in number of correctly recognized items and no significant interaction was noted with gender and any of other variables.

Spanish-English bilingual data. There was a significant difference in total number of correctly recognized items between the three proficiency groups, F (2, 173) = 11.357, $p < .0001$. Subjects in the English-dominant group (M = 45.07) correctly recognized the presenting mode of each stimulus item significantly more than the Spanish-dominant group (M = 39.54), $p = .007$, and the Balanced group (M = 39.38), $p < .0001$. There was also a significant difference in number of correctly recognized items between English and Spanish codings, F (1, 173) = 4.057, $p = .046$. Items that were coded in Spanish (M = 21.23) were more correctly recognized for their presenting mode than English-coded items (M = 20.47), $p = .004$. However, as can be seen in Figure A8-5, the pattern of the number of correctly recognized items in the two languages was not significantly different for the three proficiency groups so there was no significant interaction between coding language and proficiency group.

The difference in number of correctly recognized items was examined between English and Spanish for each of the proficiency groups, (see Figure A8-5). For the English-dominant group, the mean number of Spanish items (M = 23.00) was significantly higher than English items (M = 22.07), t (70) = 2.458, $p = .016$, and for the Balanced group, Spanish items (M = 20.10) were more correctly recognized their presenting mode than English items (M = 19.28), t (80) = 2.042, $p = .044$. No difference was noted

[Figure A8-5] Mean Difference in Number of Correctly Recognized Items for the Three Spanish Proficiency Groups by Coding Language

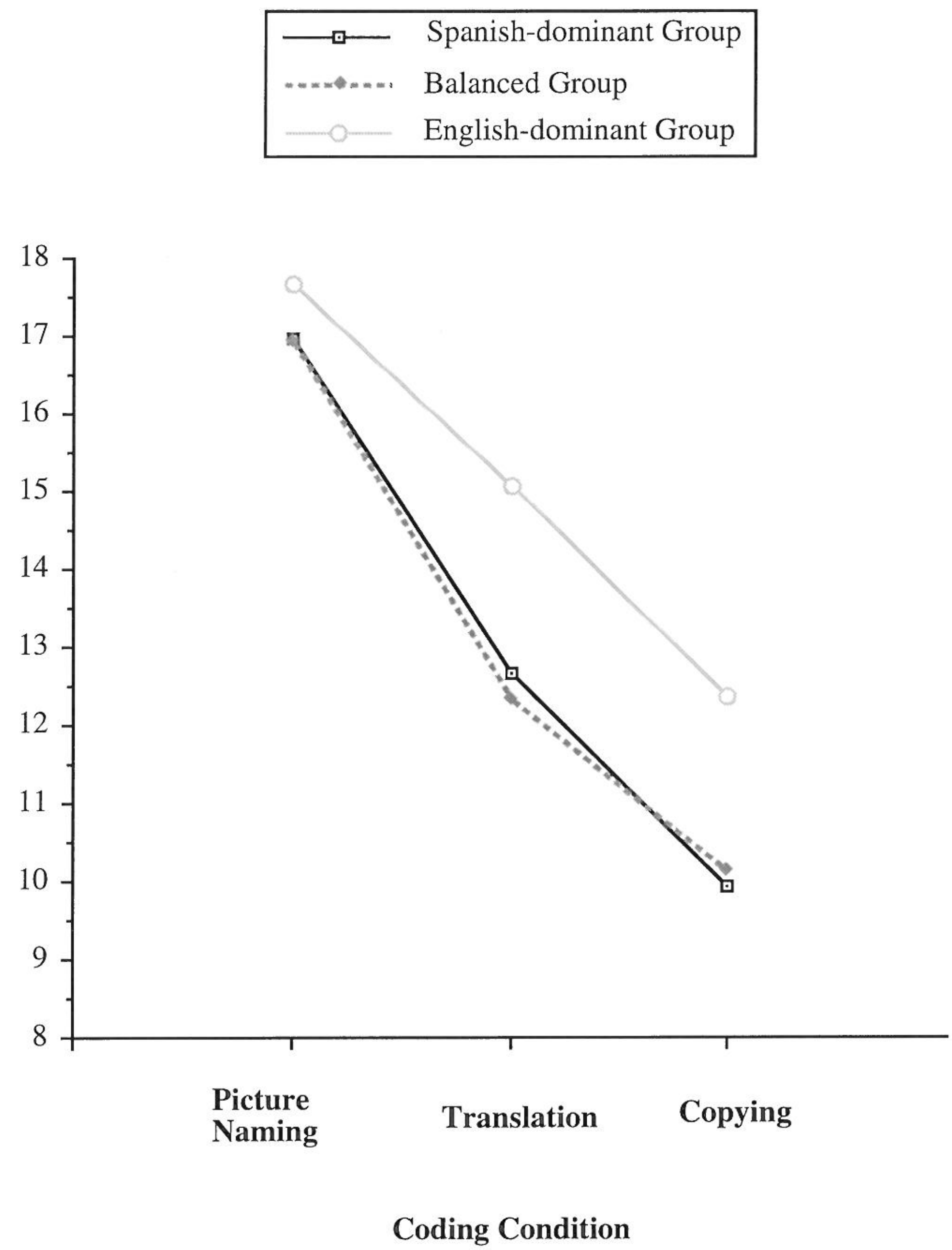


between the two languages for the Spanish-dominant group. The number of correctly recognized items between the proficiency groups was next examined in each of the languages, (see also Figure A8-5). In English, a significant difference in number of correctly recognized items was found between the proficiency groups, F (2, 173) = 7.932, $p < .0001$. The mean number of correctly recognized items for the English-dominant group (M = 22.07) was significantly higher than that of the Spanish-dominant group (M = 19.75), t (93) = 2.448, $p = .016$, and the Balanced group (M = 19.28), t (150) = 3.849, $p < .0001$. There was no significant difference found between the Spanish-dominant and Balanced groups. In Spanish, a significant difference in number of correctly recognized items was also found between the proficiency groups, F (2, 173) = 11.644, $p < .0001$. The mean number of correctly recognized items for the English-dominant group (M = 23.00) was significantly higher than that of the Spanish-dominant group (M = 19.79), t (93) = 3.480, $p = .001$, and the Balanced group (M = 20.10), t (150) = 4.615, $p < .0001$. There was no significant difference found between the Spanish-dominant and Balanced groups.

The mean number of correctly recognized items was examined by coding condition. There was a significant difference in number of correctly recognized items between the three coding conditions, F (2, 350) = 235.480, $p < .0001$. The mean number of correctly recognized items in the Picture-Naming condition (M = 17.23) was significantly higher than that of the Translation condition (M = 13.47), t (175) = 13.326, $p < .0001$, and the Copying condition (M = 10.99), t (175) = 20.662, $p < .0001$. There was also a significant difference between the Translation and Copying conditions, t (175) = 8.727, $p < .0001$.

In order to see the difference in number of correctly recognized items by coding condition and proficiency group, a two-way ANOVA was calculated. A significant interaction effect between coding condition and proficiency group was found, F (4, 346) = 3.201, $p = .013$. As can be seen in Figure A8-6, the number of correctly recognized items for the English-dominant group was significantly higher than the other two groups, but the significant difference was noted only in the Translation and Copying conditions but not in the Picture-Naming condition. In the Translation condition, there was a significant difference in number of correctly recognized items between the proficiency groups, F (2, 173) = 12.065, $p < .0001$. The mean number of correctly recognized items for the English-dominant group (M = 15.06) was significantly higher than that of the Spanish-dominant group (M = 12.67), t (93) = 2.968, $p = .004$, and the Balanced group (M = 12.32), t (150) = 4.899, $p < .0001$. In the Copying condition, there was also a significant

[Figure A8-6] Mean Difference in Number of Correctly Recognized Items for the Three Spanish Proficiency Groups by Coding Condition



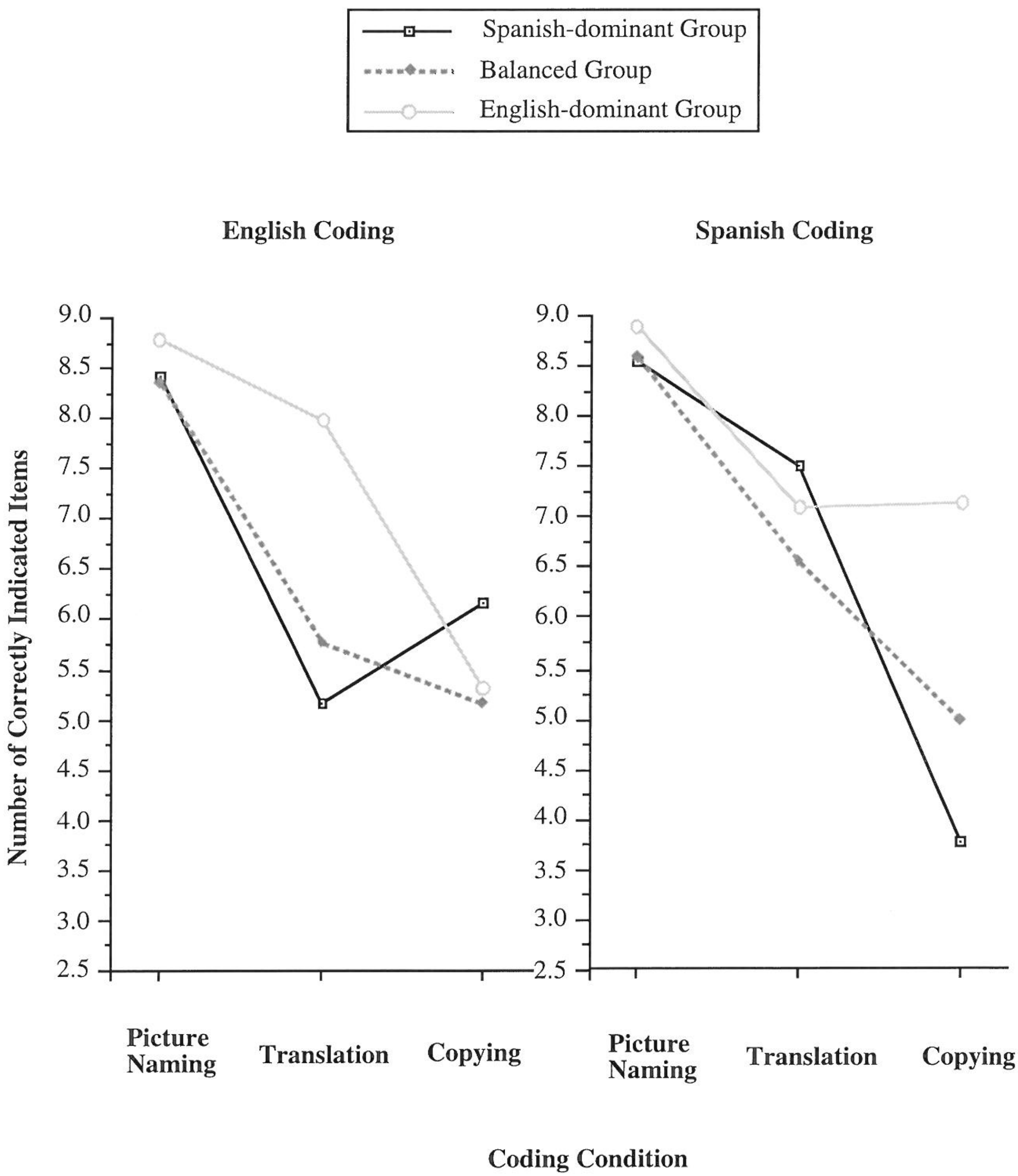
difference in number of correctly recognized items between the proficiency groups, $F(2, 173) = 7.284$, $p = .001$. The mean number of correctly recognized items for the English-dominant group ($M = 12.35$) was significantly higher than that of the Spanish-dominant group ($M = 9.92$), $t(93) = 2.796$, $p = .006$, and the Balanced group ($M = 10.12$), $t(150) = 3.499$, $p = .001$.

In order to see the difference in number of correctly recognized items across all three variables: coding language, proficiency group, and coding condition, a three-way ANOVA was performed. Other than a significant difference by proficiency group, coding language, and significant interaction between coding condition and proficiency group, there was a significant interaction between coding language and coding condition, $F(2, 346) = 6.540$, $p = .002$. Moreover, a significant three-way interaction across all three variables was also found, $F(4, 346) = 24.668$, $p < .0001$.

A significant interaction effect between coding language and coding condition in number of correctly recognized items was first examined. As can be seen in Figure A8-7, the number of correctly recognized items in English ($M = 6.15$) in the Translation condition was significantly lower than Spanish items ($M = 6.64$), $t(161) = 2.267$, $p = .025$. However, on the contrary, the number of correctly recognized items in English ($M = 5.16$) was significantly higher than the Spanish items ($M = 3.98$), $t(161) = 4.586$, $p < .0001$. There was no difference in number of correctly recognized items between the two language codings in the Picture-Naming condition.

A significant three-way interaction by coding language, proficiency group, and coding condition was next examined. As can be seen in Figure A8-7, in English coding, the pattern of number of correctly recognized items in the three coding conditions was different for the proficiency groups. The mean number of correctly recognized items for the English-dominant group ($M = 7.97$) in the Translation condition was significantly higher than that of the Spanish-dominant group ($M = 5.17$), $t(93) = 5.582$, $p < .0001$, and the Balanced group ($M = 5.77$), $t(150) = 6.092$, $p < .0001$. However, the difference in number of correctly recognized items between the three proficiency groups was not significant in the Picture-Naming and Copying conditions. Moreover, in the Copying condition, the mean difference between the Spanish-dominant and Balanced groups was noted, although not significant. The mean number for the Spanish-dominant ($M = 6.17$) was noticeably higher than that of the Balanced group ($M = 5.16$), $t(103) = 1.894$, $p = .061$.

[Figure A8-7] Mean Difference in Number of Correctly Recognized Items by Coding Condition and Proficiency Group in Two Language Codings



On the other hand, in Spanish coding, a different finding was noted (see Figure A8-7). The pattern of number of correctly recognized items in the three coding conditions for the Spanish-dominant group was significantly different from the other groups. The mean number of correctly recognized items for the Spanish-dominant group (M = 7.50) in the Translation condition was significantly higher than that of the Balanced group (M = 6.56), t (103) = 2.052, $p = .043$, while the Spanish-dominant group's number of correctly recognized items (M = 3.75) in the Copying condition was significantly lower than that of the Balanced group (M = 4.96), t (103) = 2.156, $p = .033$, and the English-dominant group (M = 7.03), t (93) = 6.561, $p < .0001$. The mean number for the Balanced group was also significantly lower than that of the English-dominant group, t (150) = 5.546, $p < .0001$. There was no gender difference in number of correctly recognized items and no significant interaction was noted with gender and any of other variables.

Comparisons of Korean-English and Spanish-English bilingual data. There was a significant between-group difference in number of correctly recognized items by bilingual language group: between the Korean-English and Spanish-English bilingual groups, F (1, 332) = 7.752, $p = .006$. The total mean number of correctly recognized items for the Spanish-English bilingual group (M = 41.70) was significantly higher than that of the Korean-English bilingual group (M = 38.78). Moreover, a significant interaction was found between bilingual language group and proficiency group, F (2, 332) = 4.085, $p = .018$. A test for mean difference effect showed that the significant difference was found for the English-dominant group. The mean number for the English-dominant group in the Spanish-English bilingual group (M = 46.50) was significantly higher than that of the English-dominant Korean-English bilingual group (M = 38.69). There was no significant difference between the Korean-English and Spanish-English bilingual groups in number of correctly recognized items for the Balanced and Korean (or Spanish)-dominant groups.

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